

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1906.

GENERAL PHYSICS.

1004. *Influence of Vibration in Brittleness Phenomena.* C. de Fréminville. (Soc. d'Encouragement, 108. Rev. de Métallurgie, pp. 61-73, March, 1906.)—Some examples are given in which apparent brittleness under shock may be in part explained as the effect of "elementary vibrations" (stress waves) in the body. The author has made experiments in which a ball, usually of hardened steel, is dropped on flat surfaces of various materials. The curves given indicate that the height of rebound, in a given case, is a practically constant fraction of the height of fall, until beyond a certain height it is a diminishing fraction. If the ball fall on a small block of steel resting on a large anvil, the block tends to rise after the ball, and thus somewhat less energy is restored to the ball than is the case when the block rests on a lump of rubber. A ball rebounds from a cemented mild steel surface just as from a quenched steel block, similar in other respects, but much better from quenched steel than from mild steel. It was observed that when a ball was allowed to fall repeatedly from the same height upon the surface of a piece of steel, there was a very slow increase in the height of rebound, possibly due to the cold working of the surface, and there was an occasional exceptionally high rebound, as though when the ball fell on a more thoroughly worked area. The article contains various other detail results and conclusions.

F. R.

1005. *Torsional Strength of Trapezoidal and Triangular Section Bars.* C. Bach. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 481-483, March 31, 1906.)—The author gives the following rule for finding a rectangular section equivalent in torsional strength to a trapezoidal or isosceles triangular section:—Through the feet of the perpendiculars from the centre of gravity on the two equal sides draw lines parallel to the axis of the figure; these, and the other two sides, or the base and a parallel line through the apex, will form the equivalent rectangle. If the sides of the rectangle be b and h , the maximum stress under a twisting moment T will be $4.5T/b^2h$. Experimental results are given in support of the rule. Cast-iron bars were used, of such dimensions that the results are of practical value. The maximum stress for a rectangular section, calculated by the above formula from the twisting moment required to produce rupture, was 3,353 kg./cm.² The maximum stresses for trapezoidal,

isosceles, and equilateral triangular sections found by the above rule were 3,498, 3,097, and 3,430 kg./cm.² respectively, these differing by +4, -7, and +2 per cent. respectively from the result given by the rectangular section. The tensile strength of the cast iron employed was 2,252 kg./cm.², and the bending stress required for rupture was 3,405 kg./cm.² F. R.

1006. *Stresses in a Rotating Disc of varying Breadth.* M. Gröblier. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 535-537, April 7, 1906.)—The equation connecting the extension at any point due to the rotation with the distance from the axis r , the section of the disc u , the angular velocity, the density and elasticities, is integrable if $u = ar^{2\beta}$, where a and β are constant. The author therefore proposes to divide the disc into annuli, to calculate for each the suitable values of a and β for its varying breadth to be represented by the above equation, to determine the corresponding extensions and to deduce the corresponding stresses. The law of variation of u with r is also determined for there to be no variation within the disc of either the tangential or the radial stress. R. E. B.

1007. *Quasi-waves of Explosion in Fluids of Low and of Good Thermal Conductivity.* P. Duhem. (Comptes Rendus, 142. pp. 612-616, March 12, and pp. 750-752, March 26, 1906.)—In continuation of a former paper [see Abstract No. 687 (1906)] it is first shown that, when a quasi-wave of explosion is propagated with a real velocity in a badly-conducting fluid, the density is greater at its head than at its tail, and that such a wave can be propagated with a real velocity, however large the discontinuity, if the fluid expands with rise of temperature. The second paper is an interpretation for good conductors of an inequality given in the former paper [*loc. cit.*]. The author concludes that Helmholtz's meteorological theory, wherein it is assumed that two masses of air at different temperatures can glide on each other, is admissible only if we can look upon air as rigorously devoid of both conductivity and viscosity. R. E. B.

1008. *Variation of Air-resistance with the Shape of the Moving Body.* A. Frank. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 593-602, April 21, 1906.)—A continuation of experiments described in Abstract No. 926 (1905). After repeating the theory, experimental results are given in curves and tables. In the tables the resistance of solids of circular section, moving in the direction of the cylinder axis, is expressed by $\gamma k F v^2 / g$, where F is the sectional area and γ , k , v , and g represent density of air, the shape constant, the velocity and the gravitation constant respectively. The value of k for such solids varies from 0.2080 to 0.553 according as the cylinder is provided with a long pointed end or a flat end. When a cylinder moves at right angles to its axis, it experiences a resistance given by $\gamma (kF + c) v^2 / g$, where $c = 0.00163$, and $k = 0.3681$. When the section of the moving solid is square, the resistance is given by $\gamma k F v^2 / g$ as before, where k varies from 0.582 for flat-ended bodies to 0.2814 for bodies with wedge-shaped ends, the end surfaces making angles of $20^\circ 49'$ with the axis. G. E. A.

1009. *Diffusion of Air through Water.* H. Mache. (Phys. Zeitschr. 7. pp. 316-318, May 1, 1906. II. Phys. Inst. d. Univ., Wien.)—When cold air-saturated water is allowed to stand in a warm room, bubbles are formed on the sides of the vessel. If these do not grow sufficiently to rise and burst at

the surface, they will gradually disappear by a process of diffusion, the reason being that the pressure inside the bubble is greater than that in the free air on account of the curvature of the surface of the bubble and the surface tension of the liquid. An expression for the rate of decrease of the bubble in terms of the absorption coefficient and coefficient of diffusion is obtained, and it appears that the bubble diminishes by equal volumes in equal times. Observations are made by observing the bubbles formed on the bottom of a crystallising basin, by means of a microscope, and the above law is confirmed. The coefficient of diffusion calculated from these observations is 1.7 c.cm. per day for a pressure gradient of one atmosphere per cm., the temperature being 17.7° C. This agrees very well with the results of Stefan (1.71) and G. Hüfner (nitrogen 1.78 and oxygen 1.62). S. G. S.

1010. *Gaseous Osmosis across a Colloidal Membrane.* J. Amar. (Comptes Rendus, 142, pp. 872-874, April 9, 1906.)—When the dry carbonic acid gas is applied during half-hour periods to the internal surface of the membrane [see Abstract No. 840 (1906)], and the pressure, measured by a petrol manometer, increased 2 mm. at a time, the amount of CO₂ absorbed increases from zero quickly at a pressure of 12-14 mm. and thereafter the increase is more gradual. When the pressure is reduced step by step the return absorption-pressure curve lies above the outgoing one. The membrane was afterwards found to absorb a certain amount of the gas. When the membrane is reversed in the apparatus, with the CO₂ below, the internal surface of the membrane is impermeable, but the outer surface is slightly permeable. A similar effect is observed when the CO₂ is above the membrane. It is concluded that gaseous osmosis across the membrane employed obeys neither the experimental laws of Graham and Bunsen nor the theories of Stefan and O. Meyer. G. E. A.

1011. *Strength of the Surface of Dye Solutions and the Electrical Action of Light on these Solutions and on Metallic Sulphides.* O. Rohde. (Ann. d. Physik, 19. 5. pp. 935-959, April 10, 1906. Extract from Inaug. Dissertation, Kiel.)—Part I.—Aqueous solutions of fuchsine and of methyl violet form after a time solid lustrous films on their surfaces. The strength of these films was determined by breaking through them with a float to which a torsion head was attached. The strength increases with the age of the film till a constant value is obtained corresponding with the formation of a film of the solid dye; experiments according to Elster and Geitel's method on the electrical effect of light also prove a gradual change of the surface up to a limit. The film does not form on alcoholic solutions of the dyes, and its formation in aqueous solutions cannot, therefore, be ascribed to evaporation, but is probably due to the operation of the forces that cause ordinary surface tension. Part II.—Experiments were made by the Elster and Geitel method on the electrical effect of light on a series of metallic sulphides in the form of mineral, of powder, and of pastilles, and it was found that the effect produced does not depend on the method of preparation of the experimental substance, but is conditioned by the character of its surface. D. H. J.

1012. *Dimensions.* P. Juppont. (Écl. Électr. 47, pp. 161-166, May 5, 1906.)—Logically the expression $F = ML/T$ is inconclusive, being based upon an assumption that the medium has no action and that M is invariable and the same both under static and kinetic conditions; and it ignores the

gravitational constant k or allows it no dimensions, whereas if we equate the Newtonian and the Galilean force we obtain $ML/T^2 = kM^2/L^2$. In electricity we now have facts pointing towards the proposition that the mass varies with the velocity; but the study of high-speed projectiles, if mechanics had begun with these, might have led to similar propositions, and the Galilean "constancy of mass" would then only have been a limiting case, applicable to low speeds, and the definition of force $= ML/T^2$ would not have assumed its present universal form. The scheme proposed by the author [Abstract No. 265 (1906)] harmonises these two points of view. The author does not think the electro-optic medium is identical with the gravitation medium, the latter being, in his view, more attenuated than the former. A. D.

1013. *Absolute Motion*. A. Schuster. (Nature, 73, pp. 462-464, March 15, 1906.)—This is a plea for the recognition of the reality of *absolute motion*, i.e., for motion in space not necessarily relative to other material bodies. Relative motion alone is *observable*; it has therefore been argued that nothing but relative motion will ever be known. Now if, dividing the stars into groups, we were to find, from both telescopic and spectroscopic observations, that the average velocity of each group relative to the solar system were the same vector u , we might conclude a relative motion $-u$ of the sun with respect to the stellar system; but if we further found that the relative velocities of the stars in each group among themselves were distributed according to the law of errors, we should conclude that the groups were independent systems, and thus not with any probability the subject of a common vector u , which reversed would therefore belong to the solar system and betoken its possession of absolute motion. We should, of course, be no nearer the determination of the *magnitude* of this absolute motion, though we should have demonstrated its *actuality*. R. E. B.

1014. *Principle of Relativity and the Fundamental Equations of Mechanics*. M. Planck. (Deutsch. Phys. Gesell., Verh. 8. 7, pp. 186-141, April 15, 1906.)—The form of the fundamental equations of mechanics by which Newton's must be replaced if the principle of relativity has general validity is here sought, and it is found that, if c denotes the speed of light in *vacuo* and $q^2 \equiv \dot{x}^2 + \dot{y}^2 + \dot{z}^2$, the equations are $(d/dt)[mx/(1 - q^2/c^2)^{1/2}] = X$, &c. These give $mc^2/(1 - q^2/c^2)^{1/2} + \text{const.}$ for the kinetic energy of the point-mass m . R. E. B.

1015. *Shadow Bands at Sunrise and Sunset*. C. Rozet. (Comptes Rendus, 142, pp. 913-915, April 9, 1906.)—Various types of moving bands of light and shade have from time to time been seen at the instants of rising and setting of the sun, and the author made special preparations to obtain definite measures of them. A white screen was arranged in a room so as to be normal to the sunlight as the sun rose from behind a hill. The bands observed were very distinct, generally straight, but at times undulated. From a discussion of 75 observations he is able to conclude that the orientation of the bands is constantly parallel to that part of the edge of the sun which is just visible. Also that the direction of displacement of the bands is always perpendicular to their orientation, but may be either direct or retrograde. The velocity of displacement varies considerably from time to time, which appears to be in some relation to the wind velocity at the time. The greatest velocities observed were from 6 m. to 8 m. per sec., and the least from 1 m. to

2 m. per sec., the ordinary velocity being from 2-4 m. per sec. They may be visible for 2 or 3 sec. after sunrise or before sunset if the shadow is from a horizontal screen, but if a vertical edge the duration may be 12-15 sec. in such cases. Breadth generally 3-4 cm. C. P. B.

1016. *Colour of Natural Waters.* W. Spring. (Rec. trav. chim. 25. pp. 32-39, 1906.)—The green and yellow tints of natural waters are due to extraneous substances, the natural colour of pure water being blue. Dissolved calcium salts, though apparently giving a green tint, due to a fine invisible suspension, have no effect on the colour of the water when adequate precautions are taken. The brown or yellow colour due to iron salts is not seen when calcium is present. The green tint is often due to a condition of equilibrium between the colour-effect of the iron salts and the precipitating action of the calcium salts. L. H. W.

1017. *Speed and Absorption of Earthquake Waves.* G. Angenheister. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 110-120, 1906.)—In some cases waves of the same type from the same earthquake reach a given station, the first directly, the second after traversing the antipodes of the epicentrum, the third after once passing the station and then going completely round the earth, &c. If T is the interval between the passage of the first two waves through a station distant H from the epicentrum, R being the earth's radius, the velocity of the waves is given by $V = 2(\pi R - H)/T$. The difficulties attending this determination are discussed, and the average value of V deduced from the observations for 5 earthquakes is 3.46 km./sec. Assuming a knowledge of V , we can determine by this method the value of H . Further, the irregularities and discontinuities in the earth's surface diminish the energy of the wave, and this diminution as deduced from the diminished amplitudes of the waves in the above cases is at the average rate of 1/40 per cent. per km. R. E. B.

1018. *Dispersion of Seismic Waves.* H. Nagaoka. (Physico-Mathematical Soc., Tokyo, Proc. 3. 2. pp. 44-51, 1906.)—The action on a seismic wave of the irregularities of the earth's crust, the mountains, lakes, &c., that lie in its path, is to dissipate its energy in giving rise to subsidiary motions, thus resembling the action of material molecules with respect to light, and, as even a mountain is but small in comparison with a seismic wave-length, the dynamical theories of dispersion may therefore be applied to seismic waves. By a simple application of this kind it is found from a discussion of observations in widely separated places that a period of 14 sec. (and sometimes its octave) appears almost invariably in different earthquakes; whether this denotes a period proper to the earth's crust or one due to the instrument used, which had a period of about 28 sec., is uncertain. The analysis further indicates that flexural vibrations also play an important part in the transmission of seismic waves, especially in the preliminary tremor. R. E. B.

1019. *Group Velocity in Distant Earthquakes.* H. Nagaoka. (Physico-Mathematical Soc., Tokyo, Proc. 3. 2. pp. 52-55, 1906.)—The author shows that with great approximation the ratio of the group velocity to the wave velocity for flexural waves is nearly 2. Observation also shows that, if a seismic wave is taken as travelling parallel to the earth's surface, the velocities

at the beginning of the first and second preliminary tremors are in the ratio 1.9. Are these numbers connected? It seems probable that the second preliminary tremor marks the wave-trains of flexural vibration of what corresponds to the most active portion of the longitudinal vibrations.

R. E. B.

1020. *Recent Advances in Seismology*. J. Milne. (Roy. Soc., Proc. Ser. A. 77. pp. 365-376, April 30, 1906. Nature, 74. pp. 42-44, May 10, 1906. Bakerian Lecture.)—Reviewing the initial difficulties encountered in devising a regular system of earthquake record, the author shows that the first catalogue containing definite information over widespread areas was made partly by the assistance of the Royal Society, and gave evidence that Japan might be divided into at least fifteen distinct seismic districts. From this it was also found that seismic activity, and possibly geotectonic changes, were different in different districts, and that areas marked by greatest seismic frequency are those which afford evidence of recent secular movements of upheaval or depression. The arrangements for transmitting and reducing records of shocks have gradually been improved, and at the present time the British Association has the co-operation of forty stations which are fairly evenly distributed over the world. From observations in progress at Przibram it appears that a seismogram obtained at a depth of 1,150 m. differs but little from one obtained at the surface, and the fact that the large earth-waves have what is practically a constant arcual velocity of about 8 km. per sec., whatever the district, suggests the idea that the crust of the earth is moved as a whole. Detailed studies of these long trajectories furnish material for computing the probable thickness of the superficial covering or crust of the globe, and it is concluded that about 80 miles is the maximum depth, at which we may look for materials having similar physical properties to those we see on the earth's surface. Beneath this depth the materials of the outer part of this planet appear to merge rapidly into a fairly homogeneous nucleus with a high rigidity. The regions of the earth's surface which are subject most frequently to earthquake disturbances are then studied, these being the western frontier of the American and the eastern frontier of the Asiatic continents, and regions which lie on a band passing from the West Indies through the Mediterranean to the Himalayas. Generally it would appear that these regions of instability are to be found along the margins of continents or tablelands which rise suddenly to considerable heights above oceanic or other plains. With regard to variations of seismic activity in summer and winter, some evidence of seasonal variation has been found in the case of sub-oceanic areas, but not so with continental areas. After examining the time phases of great earthquakes and the sharp changes of direction of the movement of the earth's pole, it is found that there is a certain degree of coincidence, but it seems not unlikely that both effects may arise from a common cause, such as the redistribution of surface material by ocean currents and meteorological causes generally. [See Abstract No. 2160 (1905).] C. P. B.

1021. *The Vesuvius Eruption and its Explosive Phenomena*. A. Lacroix. (Comptes Rendus, 142. pp. 941-944, April 23, 1906.)—The recent activity period began on May 27, 1905, when lava issued from a fissure on the northern side, about the level of the upper station of the funicular railway. The lava moved, sometimes at the rate of 6 m. per min. On April 4, 1906, the lava came, according to Mercalli, from a crater at 1,200 m. altitude. In the subsequent eruptions the fissures descended more and more and veered from

north more to the east. The lapilli which fell mostly at some distance from the crater, not close to it, consisted of the ancient rock of the cone, part of which has disappeared. Fiery clouds heavily charged with incandescent solid particles, buoyed up by vapours, were observed, as on Mont Pelée; but they did not roll down the mountain. Their occurrence seems to be determined, not by a magma of any particular chemical composition, but by the physical properties of the magma at the moment of explosion. [Errata, see p. 1288.] H. B.

1022. *San Francisco Earthquake of April 18, 1906.* C. Davison. (Nature, 73. pp. 603-610, April 26, 1906.)—The earthquake occurred at 5.13 a.m. (1.13 p.m. Greenwich mean time) without any warning tremors or earth-sounds. The first, most severe shock lasted 2 or 3 minutes; it was followed by others during the course of the day. The disturbed area seems to be a belt along the coast range, 300 miles in length and 50 miles in width. The continuous after-shocks suggest that San Francisco was near the epicentre, which was probably submarine, but great sea-waves have not been reported. The coast of California is one of the chief seismic regions of the globe. Records were obtained within a quarter of an hour all over Europe; at Birmingham the pointer of the Omori horizontal pendulum was three times swept off the drum. S. D. Townley (Science, 23. p. 756, May 11, 1906). Observations made at Ukiah, 160 km. north-west of San Francisco. H. B.

1023. *Equilibrium of the Sun's Atmosphere.* K. Schwarzschild. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 41-53, 1906.)—The equilibrium of the solar atmosphere is investigated on the assumption that it is conditioned by radiation only, and that Kirchhoff's law holds, and it is deduced that if E is the emissivity of a black body at the temperature of the atmosphere at a depth h and A , B are the outward and inward radiation at this depth—

$$E/(1 + m) = A/(2 + m) = B/m = \frac{1}{4}A_0,$$

where A_0 is the radiation at the outer limit of the atmosphere and dm/dh is the absorptive power at the depth h . On the further assumption that the absorptive power is independent of colour and proportional to the density the distributions of pressure and temperature in the atmosphere are calculated and also the brightness at any depth, and it is noted that the equilibrium of this distribution is stable if the gases composing the atmosphere are monatomic, diatomic, or triatomic, and that, while the brightness so determined is a fair representation of what is observed, the brightness calculated on the usual hypothesis of adiabatic equilibrium is far otherwise. R. E. B.

1024. *Dichroism of Solar Prominences.* J. Esquirol. (Comptes Rendus, 142. p. 757, March 26, 1906.)—Observations made with a 2-in. (50-mm.) telescope magnifying 60 times during the total eclipse of August 30, 1905, at Alcala de Chisvert, Spain, showed evidence of double colouration in the five large prominences on the north-east limb. Each of the prominences was distinctly of two parts, the more northerly being filamentous and white, the southerly portion of the more usual rose-colour. The contrast between the two zones was abrupt and gave the appearance of there not being any gradual degradation of one colour into the other. Displacement of the ocular did not affect the phenomenon. C. P. B.

1025. *Spectra of Sun-spots and Fourth Type Stars.* W. M. Mitchell. (Astrophys. Journ. 23. pp. 211-219, April, 1906.)—The author gives com-

parative tables of sun-spot spectra, as observed at Princeton Observatory, and the spectra of fourth type stars and a Orionis between the limits of $\lambda\lambda 4861-6500$. The initial difficulty of such a comparison lies in the very different powers with which the observations have been made—in the case of the sun-spots, with powerful grating spectroscopes, while the stellar spectra have only been obtained with comparatively low dispersion prism spectrographs. It is thus in many cases somewhat uncertain whether the star line corresponds to the spot line or the unaffected Fraunhofer line. That the latter is the case seems to be borne out by the fact that there are many instances of agreement between strong Fraunhofer lines and star lines, while there are very few cases where faint lines in the solar spectrum, which are much affected in the spot, have strong counterparts in the spectra of the fourth type stars. Further, the star line may have for its counterpart a group of fine lines, only a few of which are affected in the spot; an instance is the star line $\lambda 5298.2$; in the solar spectrum there is a group of seven rather faint lines near this position, only two of them being much affected in the spot spectrum. Another instance is the star line $\lambda 5658.2$, due to vanadium, which falls in a group of six solar lines of varying intensities, only two of which are much affected in the spot spectrum. The author differs from Hale's interpretation regarding the intensities of various titanium lines which appear to be present in the two spectra, and attention is drawn to the importance of magnesium in the spectra of the fourth type stars, whereas no observations of this element have been recorded at Princeton in the spot spectra. In contrast to this is the behaviour of the manganese lines, which are well affected in spot spectra, but only of minor consequence in the fourth type stars. The author concludes that it seems improbable that spots such as exist on the sun constitute a characteristic feature of the fourth type stars. [See also Abstract No. 2027 (1905).] C. P. B.

1026. *Law of Darkening of Sun's Limb.* W. H. Julius. (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 611-622, Feb. 7, 1906. Proc. 8. pp. 667-678, March 22, 1906. Astrophys. Journ. 23. pp. 812-828, May, 1906.)—The curve representing the intensity of the solar radiation from the first until the fourth contact of a solar eclipse is drawn from the observed values. This will then show us by how much the total radiation has increased or decreased between any two epochs. Of course the position of the particular wave-length which gives a variation similar to the total variation will depend on the amount of atmospheric diffusion to which the rays are subject, and this appears to cause the chief difference between the conclusion of the present author and others who have treated the problem before. He concludes by proposing to accept Schmidt's theory of regarding the sun as a gaseous body not possessing a sharp boundary, but the density and radiating power of which are smoothly diminishing along the radius. C. P. B.

1027. *Photographs of Solar Prominences with Coloured Screens.* H. Deslandres and G. Blum. (Comptes Rendus, 142. pp. 817-819, April 2, 1906.)—The authors used an apparatus during the total solar eclipse of August 30, 1905, for photographing the solar envelopes through various coloured screens, specially adapted to transmit only certain required wave-lengths. A Prazmowski photographic objective of 0.12 m. aperture and 2.90 m. focus was employed, the primary image being enlarged by a secondary magnifier of 28 cm. focus up to a diam. of 70 mm. This enlarging lens was easily adjustable so as to allow for the changes in focus

with the different screens. Light was furnished by a cœlostat. The programme was partly spoilt by clouds, but several good pictures were obtained, which could be compared with those of other observers taken under ordinary conditions. C. P. B.

1028. *Determination of Radial Motions by Objective Prisms.* E. C. Pickering. (Astrophys. Journ. 28. pp. 255-257, April, 1906. Harvard Coll. Observatory Circular, No. 110.)—In an endeavour to find a method of determining radial velocities from the great number of objective-prism spectra taken at the Harvard College Observatory, the photographs are first taken in the usual way, and then a second exposure made with the objective prism turned through an angle of 180° . The second images should be brought side by side with the first, and as near together as possible. Were there no errors, it would only be necessary to measure the distance apart of the corresponding lines of each pair of spectra, and then each star whose radial motion was known would serve to determine the constant distance apart of the lines, and the differences in distance, converted into wave-lengths, would give the required velocities of the unknown stars. The motions of the sun and earth are of course eliminated, as they are the same for all. The principal sources of error, due to the distortion of the lens, and temperature changes, are radial, and may be determined by using both co-ordinates of the lines in all the spectra. Changes in the differential refraction may be reduced by turning the prism so that the spectra may be horizontal instead of vertical. An example is given showing the appearance of a photograph of the Pleiades taken in this way. Taking the limit of measurement as $\pm 0''.1$ for star places, the corresponding velocity on the scale of the picture would be ± 8.5 km. C. P. B.

REFERENCES.

1029. *Hatchet Planimeter.* A. Kriloff. (Acad. Sci. St. Pétersbourg, Bull. 19. pp. 221-227, Nov. and Dec., 1903.)—In this paper the author first gives a *résumé* of Andrade's theory of planimeters, and then applies it to the hatchet planimeter. The author also describes a modified form of the instrument, in which he has substituted a sharp-edged wheel for the leading chisel-edge; with this form better results can be obtained. A. W.

1030. *Automatic Mercury Pump with shortened Mercury Column.* L. Ubbelohde. (Königl. Materialprüfungsamt, Mitt. 23. No. 2. pp. 63-65, 1905; and 24. 1. pp. 61-65, 1906.)—A modified Töpler pump, being more particularly an automatically acting adaptation of Stock's form of this pump (Ber. Deut. Chem. Gesell. 38, p. 2182, 1905) with a simplified MacLeod gauge.

1031. *High Vacua produced by Liquid Air.* G. Claude and R. J. Lévy. (Comptes Rendus, 142. pp. 876-877, April 9, 1906.)—Describes an apparatus intended for the practical application of Dewar's principle of obtaining high vacua by the absorption of gases by carbon at the temperature of liquid air. Thus, starting with an initial pressure of 2 mm. of mercury, in 15 min. five Crookes' tubes of a litre capacity were simultaneously exhausted. E. H. B.

1032. *Rapid Measurement of Geodetic Base-lines.* C. E. Guillaume. (Soc. Franç. Phys., Bull. 1. pp. 5-26, 1906. Journ. de Physique, 5. pp. 242-263, April, 1906.)—A description of the method, in which wires of "invar" are employed, and of the portable apparatus for carrying out the measurements.

1033. *Proportioning Ferro-Concrete Structures.* (Engineering, 81. pp. 600-601, May 4, 1906.)—This is a note drawn up by the Armoured Concrete Constructions (Coignet system) giving some rules and methods for calculating the stresses in ferro-concrete structural members—beams, slabs, pipes, and members sustaining shear. In the latter case, with rational design, the concrete may be assumed to take one half, and the metal the other half, of the shear. The working compressive stress in concrete is taken at 635 lbs. per sq. in., and the modulus of elasticity $1/15$ that of steel. F. R.

1034. *Relation of Mechanics to Physics.* A. Ziwet. (Science, 23. pp. 49-56, Jan. 12, 1906. Address to the Amer. Assoc. for Advancement of Science, New Orleans, Dec. 29, 1905.)—A résumé of the historical aspect and development of mechanics and physics from Galileo to the modern electron theory. E. H. B.

1035. *Diffusion of Hydrogen through Hot Platinum.* A. Winkelmann. (Ann. d. Physik, 19. 5. pp. 1045-1055, April 10, 1906.)—The agreement between the experimental results of the author and those of Richardson is pointed out. It is found that the results are in equal agreement with the different formulæ suggested by both observers. R. S. W.

1036. *Validity of Poiseuille's Law in the case of Viscous and Solid Bodies.* R. Reiger. (Ann. d. Physik, 19. 5. pp. 985-1006, April 10, 1906. Phys. Inst., Erlangen, Feb., 1906.)—The author has invested the viscosity of mixtures of colophonium and turpentine, which can be obtained in varying degrees of viscosity, both by the rate of flow through tubes and by surface deformation, and finds that the flow of viscous and solid bodies through narrow tubes can be represented quantitatively within wide limits by the simple assumptions which lead to Poiseuille's law. A. F.

1037. *Vortex Rings.* J. Weingarten. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 81-93, 1906.)—Vortex rings have generally been studied as to their motion; here special attention is directed to the pressure within and without them. The author concludes that infinitely thin rings could not exist in liquids as they would be subject to infinitely large tensions on and within their surface. R. E. B.

1038. *Boltzmann's H-Theorem and J. H. Jeans' Dynamical Theory.* S. H. Burbury. (Phil. Mag. 11. pp. 455-465, April, 1906.)—A mathematical discussion of Maxwell's law, Boltzmann's H-theorem, and the paradox to which this appears to lead, with the views of Jeans and the present author on these subjects. [See also Abstracts Nos. 1688 and 1689 (1905).] E. H. B.

1039. *Uniformity of Symbols for Physical Quantities.* K. Strecker. (Elektrotechn. Zeitschr. 27. pp. 457-465; Discussion, p. 465, May 10, 1906. Report of Committee of the Elektrotechn. Verein.)—This report contains a full account of the proposals of the committee appointed to deal with the question of a uniform international system of symbols for the more important quantities in physics and technology, and of the progress made in the work of collaboration with numerous scientific and technical societies, most of which have expressed their approval of the object in view. A. H.

1040. *Meteorological Observations in Western Australia, 1903.* W. E. Cooke. (Government Astronomer's Report to Colonial Secretary, pp. 5-141, 1904.)—[See Abstract No. 2498 (1904).]

1041. *Modern Views concerning the Figure of the Earth.* III. and IV. O. Z. Bianco. (Accad. Sci. Torino, Atti, 41. 1. pp. 21-43, and 5. pp. 250-270, 1905-1906.)—A general discussion, the first two parts of which appeared in vols. 39 and 40.

LIGHT.

1042. Large Reflecting Telescopes of Short Focus. H. C. Vogel. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14. pp. 382-380, 1906.)—Reflectors have shown themselves to be specially adapted for the photography of objects of definite area, such as nebulae and clusters of the more compact order, the time of exposure required being considerably less than in the case of a refractor of equal dimensions. This is due to the perfect union of colours by the reflector. Even in the best refractors, with an objective of two lenses, the achromatism leaves a good deal to be desired, and the scattering of colours increases with the dimensions. The inconvenience is especially marked in the case of nebulae having a bright-line spectrum, and it is also to be noticed that owing to the absorption of ultra-violet light by the object-glass, the image in the refractor may differ in appearance from that given by the reflector. With reflectors for spectrographic observations of nebulae and faint stars, further advantage is gained by shortening the focus relatively to the aperture. Not only is the brightness of a nebular image, which varies inversely as the square of the linear dimensions, thereby increased, but in the case of stars also, the discs due to atmospheric tremors will be smaller, and therefore brighter, with the shorter focus. Considerations such as these have led the Potsdam astronomers to experiment with mirrors of unusually short focus. The present paper is largely devoted to an account of the latest such addition to their equipment—a parabolic mirror of 40 cm. effective aperture, and 98 cm. focus, made by B. Schmidt, of Mittweida, in Saxony (at only three months' notice). Judging from the illustrations of extra-focal images, &c., the figuring must be of an extraordinary degree of accuracy. The performance of the mirror so far seems to justify the hope that when it is more suitably mounted, and completed by the addition of a spectrograph with quartz lenses, the results will surpass any hitherto attained. For example, a 2-min. exposure on the Pleiades already shows traces of nebula, and 30 min. gives as much detail as Keeler's photograph of 4 hours' exposure taken with the Crossley reflector (aperture 91 cm., focus 5.8 m.). A 40-min. exposure on the nebula about γ Cassiopeiae shows as much as Roberts' plate with 90 min. (aperture 51 cm., focus 2.5 m.). And a 10-min. exposure on the region of ϵ Orionis shows more stars than Tucker's chart of all stars in this region visible in the great 88-in. refractor of the Lick Observatory. A chart copied from this photograph is given. A. E.

1043. Constant-Deviation Prisms. T. H. Blakesley. (Phys. Soc., Proc. 20, pp. 105-106, April, 1906.)—When a prism is set in position for minimum deviation, the property which has the minimum value is the rate of passage of the ray across the field of view. If any triangle having the angles α , β , γ is adopted as the shape of a prism, the telescope must be set to make one of these angles, say γ , with the line of the collimator. Then, the prism being placed in the region between them, a position can be found so that any ray selected will be refracted through one of the sides containing the angle γ , reflected at the side opposite γ , and finally refracted through the remaining side containing γ . On emergence it will be parallel to the telescope, and its passage through the refracting faces will be "isogonal." If the prism be turned over, but the same angle γ employed, the telescope will remain

unaltered, but the spectrum will run in an opposite direction to the first. Using this property, prisms can be piled one upon another, so as to afford an excellent mode of mixing colours. The advantageous employment of spectroscopes on this plan in astronomical spectroscopy is suggested. G. E. A.

1044. *Power and Foco-facial Distances of Microscope Objectives.* L. Malaszez. (Comptes Rendus, 142. pp. 778-775, March 26, and pp. 926-928, April 17, 1906.)—Three methods are given for determining the power of an objective. In the first, the magnifications G and g are found for two different positions distant $D-d$ from each other, and the power is given by $(G-g)/(D-d)$. The second method makes use of a property described previously [Abstract No. 810 (1906)]; and the third method consists in measuring the magnification at 10 cm. beyond the posterior focus of the objective. Examples are given of concordant measurements of eight objectives made by the three methods. The magnifying power at distance d from the posterior face of the objective is $a(d-f)$ or $a(d+f)$, according as the posterior focus is behind or in front of the posterior face, a being the potency of the lens and f the foco-facial distance to be found. In the first method f is obtained from a measurement of the magnification; in the second it is determined directly by focussing first the posterior face and then the image of a distant object formed by the objective; and in the third method a Weiss focometer is employed. G. E. A.

1045. *Theory of Alkaline Photographic Development.* S. E. Sheppard. (Chem. Soc., Journ. 89. pp. 530-550, March, 1906.)—The investigation deals with the chemical reactions involved and with the statics and dynamics of photographic development. The results may be tabulated as follows:—

Developer.	R.	K.	E.	T.C.	F.
Ferrous oxalate	1	0.061	1.00	1.70	0.01N
Hydroxylamine	1	0.305	5.0	2.10	0.0118N
Quinol	2	0.146	1.2	2.80	0.0052N and 0.0078N at 84 and 40 per cent. development respectively
<i>p</i> -Aminophenol	(2) ¹	0.550	4.5	1.5	0.084N
Methyl- <i>p</i> -aminophenol...	(2) ¹	0.500	4.4	1.25	—
Hydrogen peroxide	1	—	—	—	—

¹ Varies with concentration from 1 to 2.

where R=reducing power, i.e., the number of mols. of silver bromide reduced by 1 mol. of reducer; K=velocity of development in N/10 solution at 20°; E=efficiency, or velocity compared with ferrous oxalate divided by reducing power; T.C.=temperature-coefficient or $K + 10^\circ K$; F=energy, i.e., concentration of bromide producing the same retardation as N/100 bromide with ferrous oxalate. [See also Abstract No. 1724 (1905).] D. H. J.

1046. *Properties of Thin Metallic Films obtained by Kathodic Pulverisation.* C. Maurain. (Comptes Rendus, 142. pp. 870-872, April 9, 1906.)—The author has prepared films which are strongly dichroic; their electrical

conductivity varies with the direction, the directions of maximum and minimum conductivity coinciding respectively with the directions of greatest and least absorption of luminous vibrations; the films are also birefringent, the principal sections coinciding with the two directions defined above. A plane circular cathode is employed, and the films are deposited on glass plates placed on one side normal to the cathode. The most strongly dichroic films are those of bismuth, and in any film the dichroism is feeble for those parts near the cathode. The principal directions in the film are parallel and perpendicular to the surface of the cathode. The ratio of the conductivities in directions parallel to the axes of maximum and minimum absorption was 0.8 for a portion of the film near the cathode and 0.475 for a part remote from the cathode. The same properties are found in gold films, but are less accentuated. Nickel films showing strong dichroism were formed by placing the glass plate parallel to the cathode and using a magnetic field. [See also Abstract No. 890 (1906).] G. E. A.

1047. *Prints in Natural Colours by the Pinatype Process.* E. J. Wall. (Photographic Journ. 46. pp. 144-145; Discussion, pp. 145-146, April, 1906.)—Ordinary transparencies are made from three negatives, and plates coated with gelatine and sensitised with a 2 per cent. solution of a bichromate salt are exposed under these transparencies. The plates are then freed from bichromate by washing, and stained in the dye baths. When thoroughly stained, gelatinised paper, well soaked in water, is squeezeed to one of the dyed plates and left for 10 or 15 min. The same paper is squeezeed in turn to the other plates, the blue impression being taken first. The colours are rendered more stable by immersing the print in a bath of fixative. A superimposed carbon process is also described. G. E. A.

1048. *Calculation of Hemispherical Intensity of Sources of Illumination of Definite Size.* H. Heimann. (Elektrotechn. Zeitschr. 27. pp. 880-888, April 19, 1906. Écl. Electr. 47. pp. 396-400, June 9, 1906.)—The ratio of the hemispherical illumination to the total or spherical illumination, J_h/J_s , is found for an element of surface of the source of illumination, in terms of the inclination of the normal to the element of surface to some fixed plane, say the horizontal. It is then shown that for a source whose surface is a closed surface, having the same illuminating power at all points, the hemispherical is equal to the spherical intensity ($J_h/J_s = 1$), or the radiation is the same in all directions. Next, a surface which is incomplete, but which can be closed by a plane, is dealt with, and the result applied to the case of a glow-lamp filament ($J_h/J_s = 1$), an ordinary gas incandescent mantle ($J_h/J_s < 1$), an inverted gas-mantle ($J_h/J_s = 1.5$), and a flame arc ($J_h/J_s = 1.866$). The paper closes with an account of the application of the calculation to the determination of J_h/J_s by splitting the source into horizontal zones and determining the illumination for the several zones separately, when the intensity is no longer considered to be constant over the whole surface. The intensity of the separate zones can be conveniently determined by means of the globe photometer of R. Ulbricht [see Abstract No. 1160b (1905)]. S. G. S.

1049. *Colour of the Mercury Lamp.* E. Gehrcke and O. v. Baeyer. (Elektrotechn. Zeitschr. 27. pp. 883-884, April 19, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—In order to improve the colour of the light emitted by the mercury lamp, an amalgam of zinc is used instead of pure mercury. The red line of zinc (6864) is particularly strong, and greatly

improves the colour. As the light is still deficient in yellow, sodium is next added, and it is claimed that the light is then similar to that of several Bremer lamps. To avoid the deposition of the amalgam on the walls of the lamp, 10 per cent. of bismuth is added, which completely stops this deposition: the light emitted by the bismuth is too feeble to produce any disturbance.

S. G. S.

1050. *Relation between Absorption Spectra and Chemical Constitution. I. Chemical Reactivity of the Carbonyl Group.* A. W. Stewart and E. C. C. Baly. (Chem. Soc., Journ. 89, pp. 489-501, March, 1906.) II. *The Quinones and α -diketones.* E. C. C. Baly and A. W. Stewart. (Ibid. pp. 502-514.)—I. Attention is drawn to the exceptional chemical reactivity of the carbonyl group, and it is suggested that in most cases the phenomena of tautomerism furnish an explanation of this reactivity. The passage from the enolic to the ketonic form may be supposed to give rise to a specially active carbonyl radical in a condition that we may describe as "nascent." In some cases, however, this explanation fails, and the authors therefore introduce a wider conception. From spectroscopic evidence it appears that in the α -diketones a vibration is going on which is similar to what occurs with ethylacetacetate and its derivatives, but cannot be expressed by the ordinary structural formulæ without misconception. The two extreme phases of the vibration may be represented by the formulæ: (I) $\begin{array}{c} \text{—C:O} \\ || \\ \text{—C:O} \end{array}$ (II) $\begin{array}{c} \text{—C:O} \\ | \\ \text{—C:O} \end{array}$

The conversion of I. into II. would give rise to the "nascent carbonyl group." The new type of oscillation described by the authors is called by them isorropesis. II. It is shown that isorropesis in α -diketones results in the absorption of light in the visible blue region, so that the substances are intensely yellow. This is evidenced by camphor quinone and diacetyl. By analogy, the isorropesis between the carbonyl groups in juxtaposition, may be considered to account for the yellow colour of benzo-quinone, p -xyloquinone and other quinones. It is possible that colour and fluorescence are evidences of the same phenomenon—isorropesis. In the former case the isorropesis provides the mechanism and incident light actuates it; in the latter case the isorropesis both provides and actuates the mechanism.

D. H. J.

1051. *Spectrum of the High-tension Arc in Air.* B. Walter. (Ann. d. Physik, 19. 4. pp. 874-876, March 27, 1906. Physikal.-Staatslaborat., Hamburg, Feb. 23, 1906.)—The author has observed the spectrum of the high-tension arc in air produced by a large induction coil and Wehnelt interrupter, and found six bands, five of which agree with the five most refrangible bands measured by Eder in the flame-spectrum of ammonia. The sixth band, at $\lambda=2157$, is faint, which accounts for Eder not having seen it. The first two bands measured by Eder do not appear in the high-tension arc spectrum, and the author for this reason attributes them to a different source from that of the other bands. This is confirmed by the fact that they have an entirely different structure. The author attributes them not to ammonia, but to some nitrogen-oxygen compound.

E. C. C. B.

1052. *Spectrum of Hydrogen in the Region of extremely Short Wave-length.* T. Lyman. (Astrophys. Journ. 23. pp. 181-210, April, 1906.)—The completion of the measurement of the lines of the hydrogen spectrum of very short wave-length of which preliminary notice has already appeared

[Abstract No. 1415 (1904)]. A concave grating was employed and the two-slit method adopted for purposes of measurement. The wave-lengths have been measured to $\lambda = 1,080$, a complete table being given in the paper. Further, it was found that fluorite only transmits the rays as far as $\lambda = 1,230$. Hydrogen does not possess any secondary spectrum beyond $\lambda = 2,000$.

E. C. C. B.

1053. *Broadening, Doubling, and Reversal in Spectrum-line Structure.* P. G. Nutting. (Astrophys. Journ. 23. pp. 220-232, April, 1906.)—Using an echelon spectroscope, the author finds the varied appearances presented by spectrum lines under varied conditions may be divided into five classes, and two of these are specially considered in the present paper, viz., (a) lines which simply broaden indefinitely as their intensity is increased, about half of which show superposed structure just before reversal; (b) lines which twin at an early stage with sharp, widely-separated components. The phenomena are treated analytically with respect to Kirchhoff's law and the theory of gases, the constants involved being determined by the echelon. It is claimed that the echelon has sufficient resolving power to justify the recognition of considerable detail in the structure of a spectrum line 0.2 tenth-metre broad, and an echelon of 30 plates, each 10 mm. thick and with steps of 1 mm., has a dispersion about equal to the second order spectrum of a 21-ft. concave grating, but its resolving power will be about ten times as great as that of the grating. Full discussion is given of the effects produced by damping the molecular vibration, impact, Doppler-effect, rotation, and outside influences, such as a magnetic field, and the author suggests that such spectroscopic measurements may supply valuable data for the kinetic theory of gases, and the theory of magnetism. [See also Abstract No. 704 (1906).]

C. P. B.

1054. *Attempt to find Cause of Width and of Pressure-shift of Spectrum Lines.* W. J. Humphreys. (Astrophys. Journ. 23. pp. 233-247, April, 1906.)—In this paper the author assumes the conception of J. J. Thomson that an atom consists of negative electrons in a sphere of uniformly distributed positive electricity. If the electrons are moving in circular orbits, each ring will produce its own magnetic field, and therefore the system will possess minimum potential energy when the planes of the rings are parallel and all the electrons are rotating in the same direction. He then considers the mutual actions of this type of atom when in a gaseous condition, taking the specific case of iron atoms in the arc. From these considerations he arrives at certain general deductions. First, that only neutral atoms and positive ions can give spectrum lines, and that each would probably give radically different lines. Second, under reduced pressures the lines would be at their narrowest, any measurable width being due to line-of-sight motion. If λ be the wave-length when there is no motion, and λ_1 the modified value produced by line-of-sight velocity, then $\lambda - \lambda_1$ will be symmetrical about the point of maximum intensity, proportional to λ and to the square root of the absolute temperature, and inversely proportional to the square root of the atomic weight. Third, with increased density there will be three causes of broadening: (a) temperature line-of-sight motion; (b) line-of-sight motion due to attractions and repulsions of the atoms; (c) the mutually induced currents in the atoms. Both a and b will produce symmetrical broadening, while c will produce unsymmetrical broadening towards

the red. Finally the author shows that all the observations upon the width and pressure-shift of lines [see Abstract No. 295 (1906)] can be accounted for.

E. C. C. B.

1055. *Relation between Velocity of Translation and Intensity of Radiation of the Canal Rays.* J. Stark. (Phys. Zeitschr. 7. pp. 251-256, April 15, 1906.)

—The positive ions constituting the canal rays must have velocities varying from zero up to that acquired by traversing the whole of the cathodic dark space; hence if the atoms emit light to an extent independent of their velocity, the Doppler-effect should consist in a broadening of the line into a band [see Abstracts Nos. 297 and 521 (1906)]. That this is not the case is shown by the author in the present paper: between the position of the "rest" line and the displaced line is an interval of minimum radiation which shows that the maximum radiation occurs at one particular velocity of translation of the positive ion. The author explains this by saying that the source of energy of the emission of light by the canal rays is the kinetic energy of translation, and that equilibrium between the two forms of energy is brought about by means of the radiation-pressure. It follows that the intensity of radiation is a function of the square of the velocity. From measurements of the width of the space between the "rest" line and the displaced line, the velocity of translation can be calculated on Doppler's principle; it is then found that in order to obtain the same intensity of radiation for waves of different frequencies, a greater velocity of translation is necessary for a wave of shorter than for one of longer wave-length. Further, the maximum radiation for the lines of a series occurs at lower velocity for a wave of greater length than for one of shorter wave-length, and the intensity increases more rapidly with increasing velocity in the case of a wave of shorter length than in that of one of longer wave-length. The author considers that the emission of light by the Bunsen flame, impregnated with the vapour of one of the alkaline metals, takes place on account of the atoms being ionised, and the positive ions moving with high velocity (*i.e.*, have high temperature). In the case of three mercury lines belonging to different series which are investigated, it is found that for the first line (2536.72) the displacement (and hence velocity) is small and the intensity considerable; for the line 4046.78 the displacement is greater and the intensity less, and for the line 4078.05 the displacement is still greater and the intensity less. This accounts for the fact that only the first of these lines can be produced in the Bunsen flame [see Abstract No. 706 (1906)], the temperature being sufficient, and the velocity great enough, to produce this line but not the other lines.

S. G. S.

1056. *Variation of Absorption Bands of a Crystal in a Magnetic Field.* J. Becquerel. (Comptes Rendus, 142. pp. 874-876, April 9, 1906.)

—When the ray of light is directed along the lines of force, to which the optic axis of the crystal has been made parallel, the effect of the magnetic field is to cause a diffusion at the edges of all the bands of the ordinary spectrum which alone is visible. When the light emerging from the crystal is analysed by means of a nicol, the intensity of the two components remains constant for all positions of the nicol. But if the axis of the crystal is inclined several degrees to the lines of force, there are two symmetrical positions, independent of the field but depending on the thickness of the crystal, for which the components are plane-polarised. When a quarter-wave plate is employed in analysing the light another effect is observed, in which circular vibrations in the same sense

are not all displaced in the same direction on exciting the field. For the band 522.14, in which the doublet attains in a field of 80,000 the separation of the D lines, the effect is in a sense contrary to that hitherto observed in manifestations of the Zeeman-effect. [See also Abstract No. 886 (1906).]

G. E. A.

1057. *Spectra of Alloys.* J. de Kowalski and P. B. Huber. (Comptes Rendus, 142. pp. 994-998, April 30, 1906.)—It is known that on intercalating a self-induction in the circuit of the oscillating discharge of a condenser the air lines and certain lines of the metal forming the electrodes disappear from the spectrum of the discharge. When the electrodes are of pure metal more lines disappear, on putting in the self-induction, than in the case of electrodes of alloy. With Cu-Zn or Cu-Mg electrodes the lines which do not disappear belong to copper; the wave-lengths of these lines are given, and they have all, with one exception, been observed by Kayser and Runge in the arc spectrum. The phenomena can be explained by means of J. J. Thomson's idea that emission of light by a corpuscular system forming part of an atom only takes place if the value of the internal energy of the system is over a certain minimum. They can also be explained by supposing that the mean temperature of discharge between alloy electrodes is higher than that between electrodes of pure copper. This would require the temperature of vaporisation of the alloy to be higher than that of the pure metal. The arrangement employed included a capacity of 0.008 mfd., an induction coil without iron core with an inductance of about 0.1 henry and a spark-gap of 8 mm.; and the spectra were photographed.

G. E. A.

1058. *The Infra-red Spectrum.* M. Stefanik. (Comptes Rendus, 142. pp. 986-988, April 30, 1906.)—The author draws attention to the advantage in exploring the extreme red spectrum, of employing screens which absorb the whole ordinary visible spectrum. By their aid the observer can see much further into the red, probably owing to the cutting off of the extraneous light usually scattered within the instrument. The author can see distinctly as far as 1μ , and sometimes further, though his apparatus is somewhat unfavourable. The Z and X groups are always easily visible, the lines π ζ σ τ more rarely so. Variations of relative intensity indicate the presence of telluric lines. In general it is found that a screen which absorbs all but a limited portion of the spectrum favours observation of this portion by darkening the background.

A. E.

1059. *Phosphorescent Calcites from Fort Collins, Colo., and Joplin, Mo.* W. P. Headden. (Amer. Journ. Sci. 21. pp. 801-808, April, 1906.)—The author describes yellow calcites which become phosphorescent on insolation, and retain this property for as much as 18 hours, whereas ordinary calcite under like conditions phosphoresces for one-third of a sec., and arragonite for 20 sec. The cause of the phosphorescence was not definitely established, but is probably to be sought in the small amount (less than 0.2 per cent.) of impurities present. This small percentage is made up of oxides of cerium, yttrium, didymium, &c.; the yttrium and erbium amount to 0.018 per cent.

D. H. J.

1060. *Measurements of Wave-length with a Modified Apparatus.* Rayleigh. (Phil. Mag. 11. pp. 685-708, May, 1906.)—A determination of the wave-lengths of certain lines relatively to Michelson's cadmium values by an apparatus

differing somewhat from that used by Fabry and Perot. In place of the air layer bounded by half-silvered surfaces and normal incidence the author observes the interference rings, first described by Haidinger, dependent upon obliquity. Further, Fabry and Perot determined the order of the rings by means of their sliding interferometer; in the present case the order number (approximately known by mechanical measurement) is determined by a series of comparisons with other fringes, the true value being arrived at by a process of exclusion. The author confirms the results of Fabry and Perot and of Michelson for four mercury lines, four zinc lines, the two sodium lines, and the cadmium lines to within 1 part in a million (a possible discrepancy of 1 in a million may occur in the case of $Zn \lambda = 6,862$.) The wave-lengths of the first six lines of helium have also been determined. E. C. C. B.

1061. *N-rays*. A. Turpain. (Soc. Franc. Phys., Bull. 1. pp. 94-100, 1906. Journ. de Physique, 5. pp. 848-849, May, 1906.)—The author made a number of observations in order to detect the action of n -rays upon a phosphorescent screen, using all the supposed sources of n -rays, such as a Nernst lamp, a file, and a magnetic or Hertzian field. The affirmative results amounted to 80 per cent. But on arranging the experiments in such a manner that the observer did not know whether the action of n -rays was to be expected or not, he found that the affirmative results were reduced to 50 per cent., thus showing that self-suggestion plays the most decisive part in them. As regards the recent measurements made by Blondlot, Mascart, Gutton, and Virtz [see Abstracts Nos. 83 (1905) and 525, 526 (1906)], he attributes the close coincidences obtained in measuring maxima of refraction to an unconscious muscular memory, and quotes figures to show that such coincidences can be obtained in similar experiments without n -rays. He asks why it should not be possible to photograph the screens with and without n -rays, and goes into the various explanations advanced for the failure of such controls. As regards Blondlot's experiment of photographing a spark under the influence of n -rays, he points out that Rubens, with the same method, obtained a negative result, and suggests that both physicists should combine to execute test experiments, as was satisfactorily done in the Pender-Crémieu controversy. E. E. F.

1062. *Nature of the α - and γ -rays*. O. Wigger. (Jahrbuch d. Radioakt. u. Elektrotonik, 2. 4. pp. 891-488, Jan. 26, 1906.)—The author made use of radio-tellurium and polonium as sources of the radiation, in order to obtain α -rays of homogeneous character, and studied the absorption of such rays with a view to obtaining evidence as to their nature. If the rays consist of small material particles, the absorption coefficient (K) should increase with the thickness of the layer passed through, the initially homogeneous bundle of rays becoming heterogeneous as a result of collisions in the absorbing medium. The experimental results obtained indicate that for the α -rays from radio-tellurium and polonium K does increase with the thickness of the absorbing layer, and the material nature of the rays is hence established. Leakage experiments from a radiotellurium or polonium rod to a copper cylinder in vacuo, show that besides the positively-charged α -rays slowly-moving negatively-charged particles are also emitted by these substances; these β -rays are magnetically deflectable. But the author's results do not confirm Becquerel's observation that the α -rays from polonium are deviable; and it is concluded that these α -rays cannot be identical with the radium α -rays. The absorption of the γ -rays was examined by the ionisation method, using a much greater thickness of lead than was employed by Rutherford and

McClelland. K is found to decrease at first with increasing thickness and then attain a constant value for 1.6 cm. thickness. This would indicate that the γ -rays consist of Röntgen rays, and not of β -rays of high velocity. To eliminate the effect of the secondary radiation produced by the γ -rays traversing the different substances, the substance was placed between the active material and a lead plate 2.8 cm. thick, the latter being at the opening to the ionisation vessel. Under these conditions K is found to be strictly proportional to the density (d) of the material interposed; the actual values for K are much smaller than those obtained by Rutherford and McClelland.

	Mercury.	Lead.	Copper.	Iron.	Zinc.	Aluminium.	Sulphur.
K , per cm.	0.288	0.241	0.191	0.159	0.141	0.064	0.040
K/d	0.0208	0.0213	0.0226	0.0211	0.0201	0.0200	0.0202

It is pointed out that only when the thickness of the absorbing layer traversed is stated, and whether the secondary radiation is eliminated or not, can a definite meaning be ascribed to these values. [See also Abstract No. 718 (1906).] L. H. W.

1063. *Radio-activity of Swedish and Norwegian Minerals.* H. Sjögren. (Arkiv Kem. Min. Geol., Stockholm, 2. 1. No. 4. pp. 1-5, and No. 6. pp. 1-6, 1905.)—The author gives an account of A. E. Nordenskiöld's researches on the radio-activity of Swedish and Norwegian minerals, which, in order of their activity, are as follows: Cleveite from Raade; uraninite from Johann-georgenstadt; orangite and yellow thorite from Svinöf; nohlite from Nohl; fergusonite from Sandöen, and orangite from Brevig; euxenite from Mörefjär; æschynite from Hitterö; xenotime from Sandöen; monazite from Raade, and fergusonite from Ytterby; malacon from Kammerfors. Columbite from Moss, ixolite from Skogböle, and hjelmite from Nya Kärarivet showed no action on a sensitive plate even after 96 hours' exposure [see, however, Abstract No. 1078 (1906)]. The paper is accompanied by photographs illustrating the actions of the different minerals. T. H. P.

1064. *Alteration in Velocity of α -particles in passing through Matter.* E. Rutherford. (Phil. Mag. 11. pp. 558-554, April, 1906.)—A preliminary account of a repetition of experiments already abstracted [see Abstract No. 1589 (1905)]. The lowest value of the velocity observed after passing through Al-foil is $0.48 V_0$, where V_0 is the initial velocity. A scattering of the rays makes deduction from the experiments more difficult. Direct experiment shows that e/m is unaltered by the passage. R. S. W.

1065. *Photographing Radium Particles by their own Light.* B. Walter. (Ann. d. Physik, 19. 5. pp. 1080-1081, April 10, 1906.)—The author has taken photographs of grains of radium bromide by means of the light emitted from the radio-active substance. Such photographs are not reproduced yet owing to their want of sharpness, due to the unsuitability of ordinary photographic lenses for work in the ultra-violet region. The plates obtained have, however, shown that there are always some parts which show a greater, and others a less marked brightness; this is believed to be due not to non-uniformity in the distribution of the activity, but, from microscopic examination, to the fissured condition of the salt at the more active portions, allowing more of the emanation to escape. [See also Abstract No. 108 (1906).] L. H. W.

1066. *New Product of Actinium.* O. Hahn. (Nature, 73. pp. 559-560, April 12, 1906.)—Godlewski has shown that a product, actinium X, can be separated from actinium [Abstract No. 1588 (1905)]. The author has been able to obtain an intermediate product which is the parent of actinium X. To this, by analogy with thorium, he gives the name radio-actinium. To a fairly strong HCl solution of actinium some sodium thiosulphate is added, and the sulphur so liberated allowed to settle in the cold. This precipitate contains the new substance; the liquid carries away actinium and actinium X. It shows strong α -ray activity, but very little β -ray or emanation. This activity reaches a maximum in 8 weeks, then decays according to an exponential law whose half period is 20 days. The same results are obtained whether Debierne's actinium or Giesel's emanum is used. R. S. W.

1067. *α -particles from Radium.* W. H. Bragg. (Phil. Mag. 11. pp. 617-682, May, 1906.)—The paper contains a variety of matter on the α -particles. The stopping power of an atom is found to be expressed by the quantity $a\sqrt{w} + bw$ (w = atomic weight, a and b constants), rather than by the simple square root law previously given. The first term is by far the most important. Although the α -particles eventually lose the same energy in every gas, they do not produce the same number of ions in each case, and the yield does not depend simply on the number of atoms in the molecule. This does not imply that it is easier to produce ions in some gases than in others; for if so there would be some influence on the stopping power of atoms dependent on the number of ions produced. But the stopping power follows a simple law; the number of ions produced does not. The energy spent by the particle in an atom and the resulting ionisation are not directly connected; there is an intervening link. Either the ions made by the α -particle produce others in the molecule in some cases, or else some never emerge from the atom. Rutherford has found that it is easier to produce saturation when the gas is removed from the ionising agent; one of the author's colleagues has been unable to confirm this observation. The author finally traverses Becquerel's views, as Rutherford previously has done, concerning the homogeneity of the α -rays. R. S. W.

REFERENCES.

1068. *Apparent Distances.* R. Daublebsky v. Sterneek. (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1685-1703, Dec., 1905.)—The subject of the under-estimation of distances, especially if great and if the objects at that distance are large, has been examined by F. Hillebrand. The present work is upon the same lines and gives an account of experiments upon street lamps of various kinds. A formula is advanced and compared with the experimental results, the two being in fair agreement. E. H. B.

1069. *Optical Properties of Crystals.* W. Voigt. (Phys. Zeitschr. 7. pp. 267-269, April 15, 1906.)—A mathematical discussion of the optical properties of crystals of the hemihedral group of the monoclinic system with special reference to the work of Sommerfeld. [See also Abstract No. 313 (1906).] E. H. B.

1070. *Remarks upon Diffraction Gratings.* B. Galitzin. (Acad. Sci. St. Pétersbourg, Bull. 18. pp. 33-52, Feb., 1903.)—Three of Rowland's best gratings supposed to contain 14,438 lines to the inch and all ruled by the same engine were examined. By direct measurement one was found to have 15,031 lines, while the other two had 14,438 lines to the inch. E. C. C. B.

1071. Spectroscopic Researches. B. Galitzin and J. Wilip. (Acad. Sci. St. Pétersbourg, Mém. 17. 6. pp. 1-112, 1906.)—In this paper the authors give detailed descriptions of their investigations into the spectrum of the mercury arc lamp, the absorption spectrum of bromine vapour and its change with temperature, and a small change in the wave-length of the mercury lines on passing the rays from a mercury lamp through bromine or iodine vapour. E. C. C. B.

1072. Ultra-violet Spectrum of Europium. W. Crookes. (Roy. Soc., Proc. 74. pp. 550-551, April 10, 1905.)

1073. Absorption Spectra of Solutions of Isomeric Complex Cobalt Salts. A. Rosenheim and V. J. Meyer. (Zeitschr. Anorg. Chem. 49. 1. pp. 28-33, March 31, 1906. Wissenschaftlich-chem. Laborat. Berlin, N., Feb. 16, 1906.)—Using a large-model Krüss apparatus fitted with a flint-glass prism of 60°, the absorption spectra of alcoholic solutions of the following cobalt salts were studied: (a) Ammonium-cobalt sulphocyanide; (b) thiourea-cobalt sulphocyanide: this is an isomer of the preceding; (c) cobalt sulphocyanide; (d) cobalt chloride. From the photographs given the spectra of (a) and (b) are seen to be quite different, but (a) and (c) are very similar, as are (b) and (d). D. H. J.

1074. Absorption Spectrum of Ozone. E. Ladenburg and E. Lehmann. (Deutsch. Phys. Gesell., Verh. 8. 7. pp. 125-135, April 15, 1906. Phys. u. photochem. Inst. d. techn. Hochschule, Charlottenburg, March, 1906.)—Description of apparatus used for preparation of ozone and obtaining its absorption spectrum photographically. Reproductions of the results are given, with the spectrum of magnesium and mercury as comparisons for wave-length measurements. The positions of the chief bands determined are given to three figures only. C. P. B.

1075. Atomic Weight and Spark Spectrum of Terbium. G. Urbain. (Comptes Rendus, 142. pp. 957-959, April 23, 1906.)—The atomic weight was found = 159.22 by determining the water of crystallisation of the sulphate. A list is given of the thirty-seven most characteristic lines of the spark spectrum. D. H. J.

1076. Spectroscopic Investigation of Urbain's Terbium Preparations. G. Eberhard. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 18. pp. 384-404, 1906.)—A measurement of the lines of the arc spectrum of terbium as prepared in a pure state by Urbain. The wave-lengths are given in a table, and they show that terbium is undoubtedly a definite element; further, observations of other fractions show that there is no element between gadolinium and terbium. [See preceding Abstract.] E. C. C. B.

1077. Spectrophotography and its Technical Applications. T. T. Baker. (Photographic Journ. 46. pp. 159-164; Discussion, pp. 164-166, April, 1906.)—A description of a grating camera suitable for photographing spectra. The plate recommended is colour-sensitised with a mixture of homocol and a black dye, and its range then extends from $\lambda 2,000$ to $\lambda 7,000$. An even spectrograph is got by the use of a yellow screen of Ceres yellow II. The discussion related chiefly to the size of grain in the plates used. G. E. A.

1078. Swedish Radio-active Minerals. J. Landin. (Arkiv Kem. Min. Geol., Stockholm, 2. 1. No. 2. pp. 1-7, 1905.)—The author has demonstrated the presence of radium in culm by preparing from it barium sulphate and testing the action of the latter on a photographic plate. The alum schists of Billinge answer to the same test, and, like culm, also contain uranium. The quantity of radium in these minerals is, however, too small to be of industrial importance. Hjelmite crystals slowly blacken a photographic plate. T. H. P.

HEAT.

1079. *Notes on the Wanner Pyrometer.* W. Nernst and H. v. Wartenberg. (Deutsch. Phys. Gesell., Verh. 8. 7. pp. 146-150, April 15, 1906. From the Phys.-chem. Inst. d. Univ., Berlin.)—Describes further tests of the Wanner pyrometer carried out in consequence of discussion on the authors' paper on the melting-point of platinum [see Abstract No. 911 (1906)]. Observations on the melting-point of gold covering a period of 7 months are given, showing the constancy of the instrument within 0.7 Wanner degrees (1° Wanner = about 6° C.). As regards calibration of the instrument with the amylacetate lamp, the authors revise their previous statement that this is inadequate, finding that this only applies if the optical system is set to read on the D line, as in that case the amount of sodium present in the air affects the brightness of the amylacetate lamp perceptibly; with instruments set to read on the red, however, calibration with the lamp is found satisfactory. Corrections of the scale of the instrument obtained by calibration with rotating sectors are given for a second pyrometer and are again found to be quite small, amounting to not more than 6° C. at the melting-point of platinum. Two instruments were compared by taking alternating observations of a blackened disc of magnesia heated in an electric furnace, and the mean temperatures found were $1,698^\circ$ C. by one and $1,695.5^\circ$ C. by the other. The calibration of the instrument by the melting-point of gold was further checked by making the gold wire part of a thermo-couple whose indications could be read up to a temperature very near the melting-point of gold; comparison of the results obtained in this way with those of the direct method previously used, gave results in close agreement. The results described in this paper are regarded by the authors as confirming the validity of their methods in determining the melting-point of platinum.

W. Ros.

1080. *Explosions of Coal-gas and Air.* B. Hopkinson. (Roy. Soc., Proc. Ser. A. 77. pp. 387-413, April 30, 1906. Engineering, 81. pp. 777-778, June 15, 1906.)—For the examination of the propagation of flame through a mixture of coal-gas and air, contained in a closed vessel and ignited at one point by an electric spark, a continuous record of the variations of temperature at various points within the mixture is obtained by continuously recording the variations of resistance of thin platinum wires at those points, the variations of pressure being also recorded on the same revolving drum. The progress of the flame can thus be traced, and from the rate of rise of the temperature of a point may be deduced the velocity with which the gases about it combine. It has been possible, at least in certain cases, to settle the question of "after-burning," which is a moot point in the theory of gas-engines, and to determine the specific heat of the mixed products of the combustion. In the explosion of a rich mixture (air/gas = 9) at atmospheric pressure in a drum of volume 6.2 cub. ft., the flame spreads with a speed of about 150 cm./sec., the pressure on the walls of the vessel does not attain the maximum reached at the centre (viz., 82 lbs./sq. in. at 1/80 sec. after the flame completely fills the vessel), the temperature of the gas at the centre rises to $1,225^\circ$ C. within 1/20 sec. after ignition by reason of its combustion, and then to $1,900^\circ$ under adiabatic

compression while the gas near the walls does not rise above $1,800^{\circ}$; convection currents, moreover, seem to have but little effect on the distribution of temperature until after the attainment of maximum pressure. In explosion of a weak mixture (air/gas = 12), however, the convection effect is important from the outset, the small portion of gas first ignited instantly rising with increasing velocity, growing at the same time by the ignition of that surrounding it, but at a rate which soon becomes considerably less than the speed with which it is rising. The maximum pressure (about 64 lbs./sq. in.) is not attained till about 2.5 sec. after firing. The experiments generally seem to show that even in the weakest mixtures combustion, when once initiated at any point, is almost instantaneously complete; that the specific heats of the products is very much greater at high temperatures than at low, and that the extent of this difference justifies the view that it is the main reason of the so-called "suppression of heat." The paper is too full of detail for complete abstraction. R. E. B.

1081. *Temperature and Efficiency of Thermal Radiation.* J. Swinburne. (Phys. Soc., Proc. 20, pp. 38-45; Discussion, pp. 45-48, April, 1906.)—It is generally supposed that some surfaces can radiate light more economically than others. The author suggests the law that "in the case of pure temperature-radiation, the light efficiency is a function of the surface temperature only." If this is the case, the colour of the light of a thermally-radiating body depends only on its temperature. Lummer and Jahnke's experimental results on the relative emissivity of a black body and platinum are quoted in support of the above law. The efficiency of a gas-mantle is explained on the assumption that white bodies have less emissivity than black. That the part of the flame at the mantle is much above the melting-point of platinum is proved by the fact that a fine platinum wire is instantly fused by the flame. The temperature of the gases is much above the melting-point of platinum, and any temperature determinations made with thermo-couples must be quite wrong. If a comparatively thick wire such as those used in thermo-couples be put into the flame, it radiates so well in proportion to the heat it receives that it keeps comparatively cool. In the discussion, J. T. Bottomley states that the question can only be settled by experiment. J. A. Harker points out the importance of the theory of thermal radiation in connection with platinum thermometers. H. L. Callendar considers the author's theory of incandescent mantles satisfactory. M. Solomon thinks that the enormous difference in the candle-powers of thoria, thoria-ceria and ceria mantles could hardly be explained by their very slight differences in colour. He suggests catalytic action as a more reasonable hypothesis. W. E. Ayrton states that his own experiments point to the conclusion that the temperature of a Bunsen flame is lowered by an incandescent mantle. He had found that small pieces of mantle heated in a platinum cup to temperatures just below the melting-point of platinum never looked brighter than the platinum. When, however, a small hole was made in the bottom of the cup, and coal-gas came in, the mantle immediately became brilliant. In reply, the Author states that the question can be settled by reasoning from known thermodynamic principles. A. R.

1082. *Vapour Pressure of a Pure Liquid at Constant Temperature.* S. Young. (Roy. Dublin Soc., Proc. 11. No. 9, pp. 89-104, May, 1906.)—An admirable defence of the theory that the vapour pressure of a pure liquid is a function of the temperature only, in opposition to the latest attack upon

it by Kohnstamm. The special sources of experimental error are detailed and discussed, as are the special difficulties to be met with and the special points that must be noted, and experimental results are given in illustration of the statements made. The author states his conviction that variability of the vapour pressure of any liquid during evaporation or condensation at moderate temperatures under otherwise proper conditions is a proof that the liquid contains air or other impurity, as in all such cases of variability noted by him the variations have disappeared on his tubes being refilled. R. E. B.

1083. *Expansion of a Gas into a Vacuum, and Determination of Specific Heat at Constant Pressure for Gases.* G. F. C. Searle. (Cambridge Phil. Soc., Proc. 13. pp. 241-249, May 15, 1906.)—It is shown by employing the thermodynamical relation $(\partial q/\partial v)_t = (\partial p/\partial t)_v$, that for a gas obeying van der Waals' law, the fall in temperature as the gas expands into a vacuum from volume v to volume v' is given by $t - t' = (a/C_v)(1/v - 1/v')$, where a is one of van der Waals' constants, and C_v is the specific heat at constant volume. For CO_2 expanding from 50 c.cm. to 100 c.cm. at initial temperature 278° , and pressure 10 atmos., $t - t'$ is about 8° . Incidentally it is shown that C_v depends upon the temperature alone, and thus, since Joly finds a variation with pressure, van der Waals' equation does not completely represent the facts. It is next shown that in determining C_p by Regnault's method the difference of pressure of the air on entering and on leaving the calorimeter is of no consequence, and does not in any way affect the result in the case of a perfect gas. The author then shows how the correction to be applied on account of the fall of pressure may in all cases be determined when the results of the Thomson-Joule porous plug experiment for the gas are known. Even when these results are not known the correction can be determined from the characteristic equation of the gas. If the pressure-difference between the ends of the spiral in the calorimeter be equivalent to a water column of 10 cm., the correction to be applied to the temperature is about $1/700$ of a degree in the case of air, and $1/168$ of a degree in the case of CO_2 , the gas entering the calorimeter at temperature 378° , and pressure 1 atmosphere. S. G. S.

REFERENCES.

1084. *Relation between Melting-point and Expansibility for the Solid Elements.* H. F. Wiebe. (Deutsch. Phys. Gesell., Verh. 8. 5. pp. 91-94, March 15, 1906.)—Carnelley gave, in 1878, the result lately published by v. Panayeff [see Abstract No. 2227 (1905)]. In 1880 the author found the relation $\alpha = 1/2.6acT$, where α is the cubical expansibility, a the atomic weight, c the specific heat, T the absolute melting-point; this joined to Dulong and Petit's law $ac = 6.4$ gives $\alpha = 1/16.6T$, which represents Carnelley's law; it further gives $(\alpha T)^2 = 1/275 = \beta$, the expansibility of gases. These relations do not apply to As, Sb, Bi, Te, Sn, I. R. E. B.

1085. *Quantitative Relation between the Specific Heats of a Gas and its Molecular Constitution.* P. Blackman. (Chem. News, 93. p. 145, March 30, 1906.)—It is suggested that a determination of the ratio $\gamma = C_p/C_v$ of the specific heats of a gas at different temperatures might furnish a means for studying the variations in the molecular complexity of the gas. T. M. L.

SOUND:

1086. Lecture Experiments to Illustrate Doppler's Principle. A. Amerio. (N. Cimento, 10, pp. 398-395, Dec., 1906.)—Two experiments are described. In the first, a jet of mercury falls vertically from a small orifice, the height of which is adjusted so that the drops in falling upon the bottom of a beaker give rise to a sound whose pitch can be appreciated. On rapidly raising the beaker the pitch rises, and while lowering it the pitch falls. In the second experiment two whistles or pipes which have the same pitch are attached to the opposite ends of a rotating arm so that one recedes from the observer as the other approaches. When the arm is at rest the simple note is heard, but on rotating the arm, beats are produced. S. G. S.

1087. Acoustic Properties of Rooms. Marage. (Comptes Rendus, 142, pp. 878-880, April 9, 1906.)—Deals with the acoustic properties of six halls in Paris, ranging from the Trocadero of volume 68,000 cub. m. with an audience of 4,500 down to the Physiological Theatre of the Sorbonne with an audience of 150, the volume being 890 cub. m. In a hall, the audience hear three sets of vibrations, (1) those received direct from the source, (2) those diffused or scattered by the walls, ceiling, &c., thus producing the sound of resonance, and (3) those regularly reflected by the walls which give the distinct echoes. For a hall to be good from the acoustical point of view, there should be no echo, and the resonance should be short enough to reinforce the original sound to which it is due instead of trespassing upon the sound following. W. Sabine has found from his experiments that the duration of the resonance can be given by $t = 0.171v/(a + x)$, where v is the volume of the room, a is its absorbing power when empty, and x the absorbing power of the spectators. The present author used as the sources of sound the five vowels OU, O, A, É, I, each synthetically produced by a siren in the place usually occupied by the speaker, the listener being successively at different points in the hall. In the largest hall, the Trocadero, holding 4,500, the mean time of resonance was 2 sec. when empty and 1.4 sec. when full. To make himself distinctly heard in this hall, a speaker must use a slow utterance, pausing at each phrase. But it is not necessary to use more energy than in addressing 250 in the Physical Theatre of the Sorbonne. In the large theatre of the Sorbonne, holding 3,000, the resonance extended almost to 8 sec. empty but was only 1 sec. or less when full. The acoustic properties of this hall are considered very good. Four other halls are studied and details given. The author concludes (1) in agreement with Sabine, that the resonance serves to characterise the acoustic properties of a hall. (2) The duration of the sound varies with the quality, the pitch, and the intensity of the primary sound, hence a hall good for a speaker may be bad for an orchestra. (3) With the formula before given we can determine the duration of the resonance as a function of the number of auditors. (4) For a hall to be good acoustically, the duration of the resonance should be practically constant at all parts of the hall, and for all vowels, and fall between $\frac{1}{2}$ sec. or 1 sec. (5) If the duration of the resonance much exceeds 1 sec., the speaker can make himself understood only by speaking very slowly, articulating distinctly, and avoiding giving to the voice too much energy. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1088. *Constitution of the Atom.* J. H. Jeans. (Phil. Mag. 11. pp. 604-607, April, 1906.)—A letter commenting on Rayleigh's recent article [see Abstract No. 556 (1906)]. Rayleigh stated an objection against regarding the atom as a system in steady orbital motion, rather than as one performing small oscillations about a position of statical equilibrium, namely, that the sharpness of spectral lines indicates a definiteness of structure such as it is difficult to imagine associated with a system of electrons in orbital motion. But it was thought the frequencies observed in the spectrum may form an essential part of the original constitution of the atom as determined by conditions of stability. The present author remarks that if this were so these frequencies would depend only on the constituents of the atom and not on the actual type of motion taking place in the atom. Thus, if the atom is regarded as made up of point charges influencing one another according to the usual electro-dynamical laws, the frequencies could depend only on the number, masses, and charges of the point charges and on the ether-constant V . But it is pointed out first that it is impossible by combining these quantities in any way, to obtain a quantity of the physical dimensions of a frequency. If, to the quantities already mentioned, another is added, say the energy of motion of the atom, then it may be possible to obtain frequencies. Here, however, the frequencies would be functions of the energy. And, as Rayleigh said, the energy must change in the course of time, whereas the frequencies, so far as known, do not. Or, instead of combining the original quantities with the energy, they may be combined with a length in such a way as to obtain frequencies. Thus Rayleigh obtained frequencies in his analysis, but only in virtue of having introduced the radius of the imaginary sphere of positive electrification. If this positive electrification, instead of being limited to an invariable sphere, were supposed free to expand under its self-repulsion, Rayleigh's ρ_0 would be indefinite, as would consequently be the frequencies also. The situation with regard to linear dimensions is precisely the same as that with regard to frequencies. It is impossible to derive a scale of linear dimensions from the quantities permanently associated with point charges and ether. Thus the atom would have no definite size, but would expand and contract indefinitely under external influences. It seems, then, that we must somehow introduce new quantities—electrons must be regarded as something more complex than point charges. And when we have once been driven to surrendering the simplicity of the point-charge view of the electron is there any longer any objection to putting the most obvious interpretation on the line spectrum, and regarding its frequencies as those of isochronous vibrations about a position of statical equilibrium? The main objection felt against this view is here supposed to lie in its being inconsistent with the point-charge view of the electron. The present author suggests that the objection applies equally to the "orbital motion" interpretation. Difficulties in connection with the Zeeman-effect are also discussed.

E. H. B

1089. *Magnetic Inertia of a Charged Conductor in a Field of Force.* O. Heaviside. (Nature, 73. p. 582, April 19, 1906.)—The author thinks there may be some misunderstanding concerning the inertia of a moving charged conductor due to the magnetic energy set up by its motion. It depends upon the distribution of the electrification, and may vary from a minimum up to infinity. No question of distortion due to high speed is involved, so the theory is quite simple. Say a sphere of radius a has any distribution of surface charge. For simplicity, let it be symmetrical round the axis of motion, so that the surface density is representable by the sum of any number of zonal harmonic distributions. The corresponding magnetic fields follow. Their magnetic energies are all independent, so that the actual magnetic energy is the sum of the separate magnetic energies. The case of a charge Q moving in an electric field F is then worked out and the magnetic energy shown to be given by $T = \frac{1}{2}\mu^2[\mu Q^2/6\pi a + \frac{1}{2}\mu c^2 F^2 \pi a^3]$.

E. H. B.

1090. *Dimensions.* L. G. MUAUX. (Écl. Electr. 47. pp. 5-9, April 7, 1906.)—Controversial paper, replying to F. Emde [see Abstract No. 840 (1906)]. It is impossible, if generality is to be conserved and contradictions avoided, to assimilate strength of current to the magnetic power of a lamina. The contradictions are traced which follow from this assimilation: if this be abandoned the dimensions of strength of current easily come out as L/T , resistance and $4\pi nX (= F/i)$ both as M/T , and magnetomotive and electromotive force both as LM/T^2 . The author's system also brings out the fact that $L = Ni$ (where N is the magnetic flux) has dimensions M , while $L = \phi i$ (where ϕ is the flux of force) has dimensions LM/T : in the former case only does self-induction play the part of a mass. The current systems are severely criticised.

A. D.

1091. *Atmospheric Electricity at Mattsee in Summer 1905.* E. R. v. SCHWEIDLER. (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1705-1785, Dec., 1905. From the II. phys. Inst. d. k.k. Univ. Wien.)—The observations of the years 1902, 1903, 1904 [see Abstract No. 1422 (1903)] were continued in July, August, and September, 1905. The dispersion (Elster-Geitel apparatus) shows a threefold daily period with maxima in the early forenoon, afternoon, and at night, and minima about sunrise, before noon, and about sunset. The curves for the dissipation of positive and of negative electricity (amplitude somewhat smaller), and for the ratio of the two values q (average $q = 0.987$) are very similar. A direct influence of the air pressure cannot be proved. On the day of the partial solar eclipse of Aug. 30 the weather was rather abnormal, but the dissipation during the eclipse not peculiar. On clear days the dissipation minima are pronounced; on thunderstorm days the dissipation values are high about 7.30 in the morning, sufficiently so for forecasting. The determinations of the ionic charges (Ebert aspiration apparatus) are not very reliable, as the apparatus did not permit of rapid working, especially not during the generally humid evening and also morning hours. There seem to be 1.2 positive ions to 1 negative; the values are highest in the morning and after sunset. The specific velocities of the ions, on the contrary, are low during these hours and high in the daytime, and appear to vary inversely as the relative humidity. The other meteorological elements do not have any distinct influence upon the ionic charges and their velocities.

H. B.

1092. *Atmospheric Electricity and Photometry during the Eclipse of Aug. 30, 1905, at Palma, Mallorca.* J. Elster, H. Geitel, and F. Harms. (Terrestrial Magnetism, 11. pp. 1-44, March, 1906.)—The authors observed throughout the days, Aug. 25 to 31, in a house situated 30 m. above sea-level near the shore, at Palma. The weather was not favourable, on the whole; the sun was clear of clouds during the eclipse, but obscured by clouds immediately after totality, which commenced at 1 h. 21 min. 51 sec. local time, and lasted 3 min. Aug. 31 was a hopeless rainy day. The potential gradient was determined with a photographically recording electrometer (by Günther and Tegetmeyer), the quadrants being joined to 1, 2, 4, 6, 8, 10, or 12 dry cells of a battery to increase the sensitiveness; the water-drop collector was a zinc cistern. The observations do not contradict the previously gained experience that the potential gradient was diminished soon after totality and increased afterwards, but more cannot be said. The dissipation values were very low on Aug. 30, and $a+$, particularly, reached a minimum—the most pronounced observed at Palma during the week—about 1 p.m. The air temperature decreased from 32°C . at 12 a.m. to 24.6°C . (its minimum) during totality, while the relative humidity rose from 50 to 60 per cent. The Ebert-Mache apparatus for determining the number and the mobility of the ions was provided with a vertical condenser with a net to keep off insects, and with a mechanism to stop the air-current through the condenser without stopping the fan; only relative observations could be made during the eclipse, as a complete set takes nearly 2 hours. The eclipse seemed to diminish the mobility rather than the number of the ions; there had been a rain shower before the eclipse, and the ions were probably laden with moisture during the fall of temperature. The special photometer, also made by Günther and Tegetmeyer, comprised a glass sphere, one half of which which was silvered inside and the silver coated by sublimation with rubidium, and a platinum loop. The light intensity is deduced from the loss of the negative charge of the rubidium under the radiation of the short waves; the longer heat-waves were filtered off through blue Jena glass. The intensity decreased steadily during the 80 min., starting with first contact, down to zero at totality. An effect of the coronal light could not be observed, and the observed intensity values were lower than the calculated ones; this may have been due to an increased absorption in the atmosphere, misty with condensed moisture owing to the fall of temperature; more probably the radiation may be less strong from the limb than from the central portion of the sun, as Schwarzschild and Villiger have proved also for ultra-violet rays. The radio-activity of the air, determined every day with the aid of a copper wire, charged up to 2,500 volts, was found to be high—higher certainly than near the shores of the northern seas; the air seems, on the whole, to be more radio-active over the Mediterranean than over the ocean; the soil from the garden was not particularly radio-active. The authors conclude that their observations do not support the assumption of a direct photo-electric influence of sunlight on the air. H. B.

DISCHARGE AND OSCILLATIONS.

1093. *Ionisation in Flames and Vapours.* F. L. Tufts. (Phys. Rev. 22. pp. 193-220, April, 1906.)—The ionisation is studied by the method previously used [Abstract No. 1178 (1904)]. In the combustion cones of a Bunsen flame there is no indication of a saturation current; such a current is possible

in the region between the cones. In an ordinary luminous gas-flame the conductivity of the upper luminous part is very small compared with that of the faintly blue lower portion. As the supply of air to a luminous flame is increased until it finally reaches the Bunsen form, the conductivity passes through two maxima. So long as the type of flame and the ratio air to gas remain constant, the conductivity increases proportionately to the supply of gas. If salt is sprayed into the flame, the supply of air which gives the maximum conductivity to the simple flame gives the maximum when salt is present. The ionisation is greater proportionately for the more dilute salt solutions. If the luminosity of the flame is varied by spraying different amounts of salt, the conductivity varies in a similar ratio. R. S. W.

1094. *Ionisation by Collision.* H. E. Hurst. (Phil. Mag. 11. pp. 585-552, April, 1906.)—Townsend's apparatus [see Abstract No. 144 (1904)] was used in order to verify the theory of ionisation by collision in the case of nitrogen and CO. The author determined the values of α and β for both gases, α being the number of ions of one kind, either positive or negative, produced by a negative ion in travelling through 1 cm. of the gas, β the number produced by a positive ion in travelling through the same distance, at a certain pressure and p.d. The results show that the values of α for CO₂ and nitrogen are of the same order of magnitude, but that β is much smaller in CO₂ than in nitrogen. All ions have the same charge. For an equal number of collisions under the same conditions a negative ion makes about 2,400 times as many new ions in CO₂ as a positive ion. In nitrogen a negative ion produces only 22 times as many new ions as a positive ion in traversing a given distance. Hence the positive ion in nitrogen differs less from the negative ion than does the positive ion in CO₂. E. E. F.

1095. *Conductivity of Vapour from the Mercury Arc.* C. D. Child. (Phys. Rev. 22. pp. 221-231, April, 1906.)—A side tube is put into a mercury vapour lamp, and it is found that this space becomes highly conducting. This conductivity is not due to ions diffusing from the arc, nor to rays sent from it. Neither is it due to conduction along the surface of the glass, and probably not to the high temperature. It is connected with a luminosity which spreads from the arc, the front of this gives the maximum conduction. It is suggested that the recombined ions are not altogether stable on account of the accretion of neutral molecules preventing them from coming into intimate contact; and that these unstable masses are readily ionised again, giving rise to the observed effects. R. S. W.

1096. *Conductivity of Air in Dwelling-rooms.* H. Dufour. (Archives des Sciences, 21. pp. 861-867, April, 1906. Phys. Zeitschr. 7. pp. 259-262, April 15, 1906.)—According to J. R. Ashworth, air which has been breathed has a higher conductivity than normal air [see Abstract No. 194 (1905)], while Elster and Geitel find by direct experiment that air which has been breathed is not ionised [Abstract No. 195 (1905)]. In order to investigate the matter further, the author determined the conductivity of the air in a lecture-room to hold 140 students, on a number of occasions both before and after the room had been used. In all cases the conductivity is greater immediately after the room has been used than immediately before, the difference being greater when there is no ventilation than when the ventilators have been working. A similar effect is observed in the case of a

sleeping-room, the experiments being performed with electric charges of both kinds. Control experiments were carried out when the rooms had been unoccupied; in this case no change in conductivity occurred. S. G. S.

1097. *Diurnal Periodicity of Ionisation in Closed Vessels.* A. Wood. (Nature, 78. p. 583, April 19, 1906.)—The author and N. R. Campbell find that two maxima and two minima in the degree of spontaneous ionisation in closed vessels occur daily. The maxima occur between 8 and 10 a.m. and between 10 p.m. and 1 a.m., while the minima are at 2 p.m. and 4 a.m. The occurrence of these maxima and minima appears to be quite independent of the temperature, which has only one maximum and minimum daily, but the variation of atmospheric potential appears to be very closely related to the above phenomenon. The curves for ionisation and for atmospheric potential are very similar, and present the same maxima and minima, the maxima of the two curves occurring together, as also do the minima. O. W. Richardson. (Ibid. p. 607, April 26.)—Richardson explains the observations of Wood and Campbell on the theory due to C. T. R. Wilson, that the surface of the earth is negatively and the upper regions of the atmosphere positively charged, while the upper regions of the atmosphere are more conducting than the lower regions, owing to the fact that at the lower pressures ionisation by collision can occur. Assuming then a given p.d. between the upper regions of the atmosphere and the earth, the potential gradient will be greater near the surface of the earth than at a considerable altitude, where the conductivity is greater. Any ionising rays coming from extra-terrestrial sources will produce more effect in the upper regions, and the potential gradient in the layers near the surface will therefore be increased. Thus the maxima of total ionisation should coincide with the maxima of potential gradient in the layers of the atmosphere near the surface of the earth. G. C. Simpson. (Ibid. 74. p. 8, May 3.)—Simpson discusses Richardson's explanation of the phenomena observed by Wood and Campbell, to which Richardson replies. (Ibid. p. 55, May 17.) S. G. S.

1098. *Photo-electric Radiation from the Arc.* R. Lindemann. (Ann. d. Physik, 19. 4. pp. 807-840, March 27, 1906. Phys. Inst. d. techn. Hochschule, Dresden.)—The radiation from the arc was made to fall on the sensitive (CuO) plate of a photo-electric cell connected between an accumulator battery of 100 cells and an electroscope. The intensity of the radiation was then measured by the time taken by the photo-electric currents released by the radiation to charge the electroscope to a definite potential. Tables and curves are given showing the relation between the intensity of radiation and the p.d., current strength, and length of arc respectively. For a given current strength the light intensity from the arc varies according to a linear law with the arc length, with homogeneous carbons. Arcs between homogeneous, cored, and impregnated (Bremer) carbons were used, and it was found that arcs between homogeneous carbons are richest in ultra-violet light. The light from various regions of the arc was studied by interposing a slit and screening off from the cell all but the region to be investigated. The most intense radiation was found to come from the violet tufts at the extremities of the electrodes, which consist of unburnt carbon vapour, and not from the surrounding aureole. The intensity of the radiation depends upon the amount of this unburnt carbon vapour continuously maintained in the arc, and upon its temperature; and it is shown that when the intensity is affected

by outside conditions it is these factors which are primarily affected. The former depends upon the energy expended at the surfaces of the electrodes, viz., the product of the sum of the anode and kathode falls of pressure and the current strength; the latter depends upon the energy spent in the arc column itself. The addition of metallic salts diminishes the fall of pressure at the electrodes and so also the amount of unburnt vapour maintained, and by lengthening the arc for a given p.d. diminishes its temperature. Thus arcs between impregnated carbons are less active photo-electrically than those between homogeneous carbons. The paper concludes with a research upon the absorption of the light from one arc during its passage through the flame of a second and similar arc. The observed values of the absorption varied between 20 and 28 per cent. [See also Abstract No. 840 (1904).]

J. D. C.

1099. *Emission of Negatively Charged Particles produced by Canal Rays.* L. W. Austin. (Phys. Rev. 22. pp. 812-820, May, 1906. Paper read before the Washington Phil. Soc., Feb. 10, 1906.)—Canal rays are either caught in a cylinder or reflected from a plate at its base, the current in each case being conducted through a galvanometer to earth. It is found that the current is greater when reflection is taking place; this is due to the emission of negative particles by the reflecting surface. Copper and brass are about equally efficient, platinum gives a greater, and zinc a less, negative emission. The number of electrons increases rapidly with the angle at which the canal rays strike the surface. The effect of ultra-violet light and kathode rays is eliminated. It is found also that the negative particles strike a plate whose plane is perpendicular to the reflector; the number impinging can be increased by a magnetic field, but cannot, by this means, be caused to reach a maximum. The emission is therefore diffuse, and the rays have velocities varying between wide limits. There is a slight diffuse reflection of the canal rays themselves. It is suggested that the mechanism of the effects observed is that taking place at the kathode of an ordinary vacuum tube. R. S. W.

1100. *Discharge in Rarefied Gases.* L. Amaduzzi. (N. Cimento, 10. pp. 886-898, Dec., 1905.)—In continuation of his work on the discharge produced by an induction coil [see Abstract No. 148 (1906)], the author uses long tubes containing various gases, the tube in each case being in series with a spinterometer as well as the secondary of the coil. On increasing the area of the anode of the interrupter the variations that take place in the discharge at atmospheric pressure were not observed, but the luminous part of the discharge in many cases split into tracts which the author calls "luminouscent." In some cases the ordinary striations can be seen within these luminous tracts. The remainder of the paper is a discussion of the method of formation of the tracts. S. G. S.

1101. *Globular Discharge.* J. Trowbridge. (Amer. Acad., Proc. 41. No. 29. pp. 629-638, March, 1906. Contribution from the Jefferson Phys. Lab. of Harvard University.)—The author repeated Righi's experiments on slowly-moving electrical luminous effects, using instead of discharges from large condensers the current from a storage battery of 10,000 cells without the interposition of a spark-gap. Luminous masses are shot out from the anode and move towards the kathode with increasing strength of current, and retreat to the anode with decreasing strength of current. But the movement of the luminous masses is towards the negative pole when the pressure in the

tube is suddenly increased by a small amount, and when the current strength is not less than 10 milliamps. The number of luminous masses increases with the strength of the current; their movement is best seen in tubes of 4 cm. internal diam. The intervals between the masses act like cathode spaces. When the current reaches 20 milliamps. the number of luminous masses becomes so large that they form a continuous discharge. The pressure in the tube varied from 4 cm. to $\frac{1}{4}$ cm. With lower pressures the ordinary form of striæ was obtained. With narrow tubes the curvature of the striæ increased, and the striæ were apparently firmly held by the walls of the tube. Townsend's ionisation theory affords the best explanation of the slowly-moving luminous effects. A non-luminous condition of ionisation may pervade the space between the poles of a battery in a wide tube at a comparatively high pressure of the containing gas, perhaps 8 cm. The positive carriers are not restrained or held back by the swifter negative carriers, which cannot manifest their energy in a limited free path. On a sudden increase of pressure, luminous clouds issue from the anode. This phenomenon seems to indicate a greater proportional falling off in the energy of the negative carriers and a manifestation of superior energy of the positive carriers. The cloud of collisions between the two moves slowly towards the negative pole, the conductivity of the gas changing under the p.d. to which the tube is subjected. Two luminous clouds can be formed by a suitable change of pressure in the tube. These clouds, after the cessation of the condenser discharges, travel slowly to the negative pole in the tube, and coalesce before they disappear in this pole. The form of the electrodes is of considerable importance. If the positive terminal is an Al plate of about 4 cm. and the negative terminal a point, the luminous masses retreat to the positive pole instead of moving to the negative pole, on an increase of pressure. The surface density on the positive plate does not seem sufficient to force a volume ionisation through an increase in the volume of the gas. The most interesting case of slowly-moving electric luminous discharges is that of the very slow retreat of the positive column when the anode is made the pole of a strong electromagnet. This retreat, while the magnetic field remains constant, occupies several minutes, and seems to indicate a decrease in the conductivity of the gas, due perhaps to an increase of temperature caused primarily by an increased admittance due to the magnetic field.

E. E. F.

1102. *Vacuum Discharges in Magnetic Fields.* J. Trowbridge. (Amer. Acad., Proc. 41. No. 29. pp. 638-644, March, 1906. Contribution from the Jefferson Phys. Lab. of Harvard University.)—Several discharge phenomena hitherto unknown may be obtained by combining strong and steady currents with high p.d.'s and strong magnetic fields. The author used cathodes in the shape of iron rods, excited by coils carrying a current of 25 amps. wound outside the vacuum tubes. At certain pressures where the free path of the molecule is short, the violet cathode-light is repelled to the edge of the circular disc forming the cathode by a magnetic field the lines of which are directed along the lines of electric discharge, and revolves with a speed depending upon the pressure of the rarefied air. This is a distinct case of unipolar rotation. When the anode is made the core of an electromagnet at high pressures, the discharge is separated into two; one a violet discharge the other a rose-coloured discharge. These discharges are brought to the centre of the disc constituting the end of the anode instead of being repelled to the edge of the disc as in the case of the cathode. The experiments

support the supposition that under certain conditions of free path the negative ion is diverted more readily from the line of discharge under the influence of the magnetic field than the positive ion; or, in other words, has a greater energy of movement around the lines of magnetic force than of energy along the lines of discharge; and that the reverse holds for the positive ion. When the cathode forms the end of a powerful electromagnet under suitable conditions the output of Röntgen rays is greatly increased. When the anode in a Röntgen-ray tube is also the end of a powerful electromagnet the application of the magnetic field results in the production of Röntgen rays from a tube which cannot be excited without the application of heat. The use of condensers in the case of low-potential coils greatly modifies the effect of the application of the magnetic field, while with coils giving sparks of over 25 cm. with comparatively large condensers in circuit, the application of the magnetic field to either anode or cathode results in greatly increased production of Röntgen rays. The application of a strong magnetic field at the anode, with lines of force along the lines of electric discharge, forms a safe and useful method of regulation of Röntgen-ray tubes. A magnetic field applied at a suitably-placed anode constitutes a magnetic rectifier for alternating currents. E. E. F.

1103. *Static Sparking-potential for Large Spark-lengths.* J. Algermissen. (Ann. d. Physik, 19. 5. pp. 1007-1015, April 10, 1906. From Dissertation, Strassburg. Écl. Électr. 47. pp. 380-381, June 9, 1906.)—The agreement between Voege's results and those of earlier workers is stated to have been attained by his collecting figures which do not relate to the same diameter of spark-ball [see Abstract No. 2718 (1904)]. The author has investigated the relation between the sparking-potential, the sparking distance and the radius of brass spark-balls, using a comparison method in which the sparking-potential is compared with that for small spark-lengths calculated after Heydweiller-Paschen (Wied. Ann. 48. p. 235, 1893). Two spark-gaps were used, the smaller across a single Leyden jar and the larger across two (or more) such jars, the sparks being shielded from one another. The capacities of the jars used being ascertained, and their ratios, the sparking-potential when the spark takes place alternatively at either gap is given by $V = V_1(1 + C_1/C_2)$, where C_1 , C_2 are the capacities of the jars, V is the desired sparking-potential and V_1 that at the smaller gap. The results obtained with spark-balls of various radii are shown in a series of curves. The author's values for V with balls of 1 cm. and 0.5 cm. radius are somewhat higher than those of Freiberg (Wied. Ann. 38. p. 281, 1889) and Heydweiller (*loc. cit.*, p. 213); for balls of 2.5 cm. radius the values agree exactly, up to 2 cm. spark-length, with those of Voigt [see Abstract No. 2308 (1904)], but from 2 to 5 cm. the difference increases very rapidly. Practically identical results were obtained using a spark-coil or an influence machine to charge the gap. L. H. W.

1104. *Relation between Sparking Distance and Voltage with Oscillations.* J. Algermissen. (Ann. d. Physik, 19. 5. pp. 1016-1029, April 10, 1906. From Dissertation, Strassburg. Écl. Électr. 47. pp. 392-394, June 9, 1906.)—For measuring the amplitude of oscillations whose frequency is over 10^6 the Braun tube cannot be employed, so that to get the max. amplitude one is dependent upon determinations of sparking distance. Bjerknes has, however, already pointed out that static sparking-potentials when applied to measurements with oscillations lead to erroneous results (Wied. Ann. 55. p. 124, 1895). The author has therefore investigated the relation between the sparking distance and voltage, using oscillations of frequencies between

10^6 and 10^8 per sec. An oscillatory circuit containing two condensers in series, an inductance, and a spark-gap is charged up by being connected to a coil or an influence machine. On the condensers being sufficiently charged, the spark bridges the gap, and oscillations are set up in the condenser circuit. If two points of the latter circuit are brought near together (at a second spark-gap) the max. value of the oscillatory sparking-voltage can be calculated from the static initial sparking-potential at the condenser terminals and the dimensions of the circuits, partly by calculation and partly experimentally. The static sparking-potential at the main gap is determined from the length of the gap and the values given by Heydweiller, supplemented by the author's static values where necessary [see preceding Abstract], in the case of frequencies under 10^6 ; for higher frequencies the ratios of the potential amplitudes at the main and the oscillatory gap were found experimentally. The sizes of spark-balls employed were 2.5, 1.05, and 0.25 cm. radius respectively, and curves are given showing the max. voltage corresponding to various spark-lengths, both when not exposed and when exposed to ultra-violet light and the light from a 10-amp. arc lamp. From these results it is seen that (1) at 10^6 /sec. the ratio *sparking distance*/max. voltage is very little different from that under static charge, and the less the greater the radius of the spark-balls; at higher frequencies the max. voltage P , corresponding to a given sparking distance, is greater the higher the frequency. (2) For frequencies much over 10^6 the curve illustrating this relation is practically a straight line, but does not pass through the origin. For not too small sparking distances, F , the relation can be expressed by an equation of the form $P = a + bF$, where a and b are constants depending upon the frequency and the spark-ball radius. (3) The difference between the curves for different-sized spark-balls, found in the static method, is very much smaller in the case of oscillations; for spark-balls of 1 cm. radius and over, the sparking-voltage for oscillations of frequency 10^6 /sec. and under is practically the same as the static sparking-potential. Ultra-violet light and the arc are found to increase the sparking distance for a given max. voltage, very slightly up to 5×10^6 /sec., considerably at 10^7 /sec., and very strongly indeed at 10^8 /sec., which accounts for the general rule observed in demonstrations of the effect of ultra-violet light on the spark—that a very high frequency be used. The effect of the radiation may, according to one way of looking at it, be considered as eliminating part of the constant portion of the discharge-potential (a in above equation), the curve then approximately passing through zero.

L. H. W.

1105. *Discharge in Gases.* E. Bouty. (Soc. Franç. Phys., Bull. 1. pp. 61-73, 1906. Journ. de Physique, 5. pp. 229-241, April, 1906.)—The constant k in Abstract No. 1915 (1905) is 8.36 for air and 18.83 for hydrogen; and the term $ak/2$ there = A , the "dielectric adhesion" of the gas in question. The presence of metallic plates, whether acting as electrodes or not, makes no difference in the values of the critical field, though the appearance of the discharge may be altered by their presence. As the distance between electrodes increases the smaller becomes the critical field: in a tube 98 cm. long, at a pressure of 0.019 mm., the critical field was found as low as 8 or 9 volts/cm.; for which reason again the conclusions previously set forth [*loc. cit.*] are reaffirmed.

A. D.

1106. *The Spark-discharge.* T. Schwedoff. (Ann. d. Physik, 19. 5. pp. 918-984, April 10, 1906. Écl. Électr. 47. pp. 300-302, May 26, and

pp. 340-342, June 2, 1906.)—Analysis is given of the conditions obtaining in spark-discharge in a gas. The fundamental supposition is that the separation of a gas molecule into free ions begins when the combined effect of increasing field strength and kinetic energy of free ions cause shattering of the molecule, the spark-discharge at once occurring. At this critical point the kinetic energy of a free ion is the difference between the work required to split up a molecule and the work done in moving the free ion through the field against friction—

$$mu^2/2 = w - h\epsilon\lambda \dots\dots\dots (I.)$$

where h = field, ϵ = charge on an ion, λ = some unknown length. If the field is sufficiently great (h_0), $w = h_0\epsilon\lambda$ and $mu^2/2 = (h_0 - h)\epsilon\lambda$. On considering the friction opposing motion of the ion, a new expression for the kinetic energy arises—

$$\frac{mu^2}{2} = \frac{ch\epsilon}{\delta} (1 - e^{-\delta l}) \dots\dots\dots (II.),$$

where δ = density of the gas; from equations I. and II. we obtain—

$$h = h_0 / \left[1 + \frac{c}{\lambda} (1 - e^{-\delta l}) \right] \dots\dots\dots (III.),$$

where l = spark-gap, $c = m/2p$, p = friction. The last equation gives the relation of electrostatic field between the discharge surfaces to the spark-gap, in terms of three constants h_0 , c , λ . In order to determine the values of these constants the author uses values obtained by Earhart and by Shaw for spark-gap and voltage. These last researches show that the constant, h_0 , is about 6,400 for air at normal conditions. Again, the value of c and λ can be found from new expressions—

$$\frac{1}{c} = \frac{1}{\log \epsilon \cdot l_1} \cdot \log \left\{ \frac{\frac{h_0}{h_2} - 1}{\frac{h_0}{h_1} - 1} - 1 \right\}, \quad \text{and } \lambda = c \frac{1 - e^{-\delta l}}{h - 1},$$

the values of the variables h , h_2 , h_1 ... being found from the researches mentioned. It is found that λ remains constant, however h and l vary. The final and the important expression is—

$$v = 800 h_0 10^{-l} / \left[1 + \frac{c}{\lambda} (1 - e^{-\delta l}) \right],$$

where v = discharge p.d. in volts. On substituting in this expression values of l between 1μ and 80μ a curve between v and l results, which agrees with Earhart's curve perfectly. This is the more remarkable as a very sudden change in gradient, a knee, occurs in the curve for p.d. at about 350 volts, so that the theory seems to be justified as far as the results of the researches of Earhart and Shaw are correct. P. E. S.

1107. *Helium Tubes with Electrolytically-introduced Sodium and Potassium*, E. Dorn. (Ann. d. Physik, 20. 1. pp. 127-132, May 11, 1906.)—The distance (in mm.) from a resonance coil at which the following different tubes became just luminous in a bright room was found to be: Helium tube (8 mm. pressure), 38; helium tube containing sodium, 78; helium tube containing potassium ($\frac{1}{4}$ mm. pressure), 120; Warburg tube (containing nitrogen and some sodium), 65. The author, however, advises for measurement purposes a tube exhausted to 1 mm. [see Abstract No. 1089 (1905). Resonance lecture experiments easily carried out with the aid of such tubes are described.

L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1108. *Standard Method of Determining the Specific Resistance of Electrolytes.* R. Threlfall. (Amer. Electrochem. Soc., Trans. 8. pp. 193-199; Discussion, pp. 200-208, 1905.)—The author measures the specific resistance of an electrolyte by the potentiometer method, making use of normal electrodes of the Ostwald type in order to connect the potentiometer to the electrolytic resistance. A long, narrow tube, containing the electrolyte, fits into two glass T-pieces, one at each end. The vertical branches of the T's give access to the platinised electrodes, while the horizontal branches are used to fix the position of testing electrodes of glass tube drawn out to long, fine points. The testing electrodes are connected in the usual way through two beakers (containing respectively the solution under examination and the liquid used in the standard electrode) with the latter. The tube containing the electrolyte is immersed in a thermostat. The main current is reversed after a group of observations, and several sets of comparisons are made alternately with the current first in one direction and then in the other. The results obtained with solutions of common salt agree with those of Kohlrausch within the errors which a mistake of 0.1° C. in the temperature would account for, and the author maintains that no other method affords so direct and accurate a means of comparing the specific resistance of an electrolyte with that of mercury. The errors of experiment are also referred to. In the *discussion*, Burgess described an apparatus which differs from that of the author in minor details which present certain advantages. C. Hering suggested the use of gold testing-electrodes, which do not polarise like platinum or carbon, in place of the Ostwald reversible electrodes. T. S. P.

1109. *Electrical Resistivity of Iron and Steel at High Temperatures.* G. Gin. (Amer. Electrochem. Soc., Trans. 8. pp. 287-289; Discussion, pp. 289-290, 1905.)—Measurements between the points of fusion and $1,800^{\circ}$ C. were made in a furnace of the induction type with a canal of great length and small section, forming an M, and resembling a large incandescent lamp, the filament of which is a stream of fused metal. The temperatures were determined by means of a Féry optical pyrometer. A volume of iron is measured and poured into the canal, and then the current is switched on the primary at 500-580 volts, and by the use of a special transformer the pressure can be varied so that the induced current is between 6,000-20,000 amps. From the known length of the canal and the volume of metal introduced its section can be deduced (the canal being of iron chromite of negligible coefficient of expansion). In order to correct for higher temperatures, the coefficient of expansion of the metal was estimated and found to approximate to 18×10^{-5} . The power, volts, and amperes spent on the iron in the canal was ascertained, and the value of the specific resistance calculated to be 16×10^{-8} ohms [microhms (?) in original] in cm. measure between $1,280$ - $1,840^{\circ}$ C. In the *discussion*, C. Hering pointed out that the result would agree with a determination of W. Kohlrausch if ohms be substituted for microhms. W. W. H. G.

1110. *Peltier-effect.* E. G. Bausenwein. (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1625-1633, Dec., 1905. From the Phys. Inst. of the German Univ., Prague.)—The Peltier-effect was examined in an iron-constantan couple with special reference to the temperature, which was varied from 0 to 800° C. Both the thermoelectric force and the Peltier-effect increase in

a linear manner with the absolute temperature. But the Peltier-effect is not proportional to the absolute temperature. Its curve cuts the axis of temperatures, not at -273° , but at -800° C. Hence this combination does not obey Thomson's law. E. E. F.

1111. *Behaviour of Selenium towards Light and Temperature.* II. *The Allotropic Forms of Selenium.* R. Marc. (Zeitschr. Anorg. Chem. 48. 5. pp. 398-426, March 19, 1906. Phys.-chem. Inst. der Univ., Leipzig.)—In Part I., the author concluded that the resistance phenomena in selenium cells could be best explained by the existence of an equilibrium between allotropic forms of selenium—each allotrope having a characteristic electrical conductivity [Abstract No. 362 (1904)]. He now, by a study of the thermal phenomena on heating and cooling selenium and by measurements of the electrical conductivity at different temperatures, gives direct proof of the existence of two allotropes (A and B) of selenium. When amorphous or fused selenium is crystallised there is always formed at first an allotrope, A, with a positive temperature-coefficient. Transformation from A to B is monotropic, and takes place at 200° and, more slowly, also at lower temperatures. If form B is kept at a temperature of 20° its electrical conductivity falls, at a rate which is increased by shaking, to 1/100 of its value. On now heating, the conductivity falls to a minimum at about 80° and then rapidly increases. Pure selenium can be made to crystallise completely by heating, and in this crystalline form it is not appreciably soluble in carbon bisulphide. D. H. J.

1112. *Electrostatic Capacity and Resistance Capacity.* F. Kohlrausch. (Deutsch. Phys. Gesell., Verh. 8. 8. pp. 151-156, April 30, 1906.)—Resistance capacity denotes the resistance of the medium between the electrodes when the medium has unit conductivity. Resistance capacities are in general easily determined, while the measurement of electrostatic capacities often proves difficult; any connection between the two may, therefore, be of service. The author draws attention to a relation between the stream lines in the one case, and the electrostatic lines of force in the other. If in the former the p.d. between the electrodes is V_1 and the current i , then the resistance capacity $K = V_1/i$. If N be a normal to any closed surface enclosing one of the electrodes, and $d\omega$ be an element of the surface, then $i = f(dV/dN)d\omega$, and $1/K = 1/V_1 f(dV/dN)d\omega$. In the electrostatic problem, when the p.d. is V_1 and the charge Q_1 , the capacity $c = Q_1/V_1$, and the total normal electric induction over any closed surface enclosing one of the bodies is $4\pi Q_1$, which is equal to $f(dV/dN)d\omega$. Hence $c = 1/4\pi K$. Thus for two concentric spheres of radii R_1 and R_2 , the resistance capacity is $1/4\pi[(R_2 - R_1)/R_1 R_2]$; as is well known the electrostatic capacity is $R_1 R_2/(R_2 - R_1)$. Other examples are given. F. E. S.

1113. *Measuring Small Alternating Currents.* W. Voegé. (Elektrotechn. Zeitschr. 27. pp. 467-468, May 17, 1906.)—The author describes a form of vacuum thermo-element in which the heating produced by the current is conveyed (conducted) to an iron constantan junction soldered to the centre of the wire, the thermo-e.m.f. resulting being read off on a galvanometer. No great sensibility appears to have been attained, the smallest current detectable being 1/6 milliamp. (= 4 mm. at 2.5 m. scale distance). A current of 0.02 amp. gives 121 mm. deflection at atmospheric pressure, and 648 mm. after exhaustion of the containing bulb. The author proposes to use the apparatus as a gauge for very low pressures (Röntgen-tube vacua). L. H. W.

1114. *Uniformly-variable High Resistances.* A. Koepsel. (Deutsch. Phys. Gesell., Verh. 8. 7. pp. 121-124, April 15, 1906.)—A method of winding resistance wire is described, by means of which very nearly continuous variation is rendered possible with sliding contacts in the case of very high resistances. The resistance wire is wound spirally upon catgut strings as in the manner of the "G" string of a cello. The strings are suitably mounted in a circular box provided with a radial contact arm, pointer and scale. The author states that by this method a resistance of 24,000 ohms per metre can be made by winding an "Excelsior" wire of 0.05 mm. diam. upon a length of 'cello "G" string, and that it can be varied by steps of 2.4 ohms. The elasticity of the gut keeps the adjacent turns from electrical contact. The relatively large surface enables greater currents to be passed than is ordinarily the case. The author suggests that variable self-inductances without iron could be made by this method. J. D. C.

1115. *Moving-coil Galvanometer for Alternating Currents.* H. Abraham. (Comptes Rendus, 142. pp. 998-994, April 30, 1906.)—The general arrangement is that of an ordinary d'Arsonval galvanometer. The permanent magnet is replaced by an electromagnet. The iron cylinder inside the coil is laminated. It is found that the induced currents in the fixed metal parts of the galvanometer tend to act on the coil, so that if there be any dissymmetry in the construction, the movable coil will be deflected to one side or the other; this difficulty can be easily compensated by putting in the air-gap a small piece of metal suitably placed. When the electromagnet is excited and the circuit of the galvanometer is closed through a small resistance, the movable coil takes up a position in which it is not threaded by any magnetic flux, and if turned out of this position a strong directive couple comes into play, which is added to that of the torsion of the suspending wire. To obviate this, a capacity shunted with a suitable resistance is put in series with the coil. E. C. R.

1116. *Electric Measuring Machine for Engineering Gauges and other Bodies.* P. E. Shaw. (Roy. Soc., Proc. Ser. A. 77. pp. 840-864, April 30, 1906.)—The measuring machines made to test and compare gauges are identical in principle and differ little from the original Whitworth machine. Mechanical-touch machines are unsatisfactory and inaccurate, and the writer has developed a machine employing point contact, the perception of contact being by means of electric touch as applied in previous devices [see Abstracts Nos. 523 (1901), 1241 (1903), and 1779 (1905)]. The machine consists essentially of two headstocks and a table in the centre, all resting on a massive cast-iron bed. The headstocks each carry micrometer screws and nuts with graduated heads. Details of the mechanism are fully explained in the text and by a photograph and drawings. The screw diam. is 1 cm., the pitch $\frac{1}{4}$ mm., the graduated head has 500 divisions, and a vernier reading to tenths gives measurements to 0.1μ . A micrometer-microscope is rigidly mounted on one of the headstocks and is used for reading a standard invar scale; by this means the end standards may be compared with line standards of length. The micrometer screws are made of silver steel, the projecting parts of the screw spindles of invar, and the terminal points of the screw spindles of iridio-platinum beads. Necessary adjustments and various tests are described, and calibration curves given for screw readings. The tests of good gauges are tabulated, the maximum error measured being 3.6μ for a 25-mm. gauge and 5.8μ for a 150-mm. gauge. The working of the machine is illustrated by additional examples. G. E. A.

ALTERNATING CURRENTS AND MAGNETISM.

1117. *Magnetic Cycles at High Frequencies Observed with the aid of the Braun Tube.* A. Schidlof. (Archives des Sciences, 20. pp. 258-267, Sept., 1905.)—The author describes a modification of the method employed by Ångström, Corbino, and by Varley, which has the advantage of giving more accurate results the higher the frequency. The magnetic material was a ring of uniform circular section, and the primary coils, consisting of two windings, in series, were placed in the usual manner one on each side of the Braun tube. The secondary bobbins, at right angles to the first, are of low resistance, but have large self-induction. The theory of the arrangement is given, and it is shown that at 1,250 cycles per sec. the error is less than 1·2 per cent. Oscillations of frequency 20,000 have also been used, with which the error is practically nil. A correction is only necessary if the secondary ampere-turns are not negligible compared to those of the primary. The arrangement is calibrated by a continuous current and the value in amps., A_1 , A_2 , determined corresponding to 1 mm. deviation of the spot in directions corresponding to field and flux respectively. The hysteresis loss W , in ergs, is given by the expression $W = 10^7 \cdot N_1/N_2 \cdot L/V \cdot A_1 A_2 \Sigma$, where V is the volume of the iron, Σ the area of the hysteresis loop in sq. mm., $N_1 N_2$ are the turns on primary and secondary respectively, and L is the self-induction in henries. The method was used to compare the magnetic behaviour of two cores of iron wire of the same chemical composition but of different cross-sections. One core was a ring of commercial 0·2-mm. diam. iron wire. The same wire drawn down to 0·04 mm. diam. was used for the other core, and the two cores were annealed together at over 600°. Both cores were practically of the same dimensions and weight, and similarly wound. The magnetic cycles of the cores under identical conditions are, however, completely different, as will be seen from the table:—

0·04 mm. WIRE.			0·2 mm. WIRE.		
H _{max.}	B.	Loss in ergs.	H _{max.}	B.	Loss in ergs.
3·5	400	negligible	3·3	1,900	1,200
4·2	600	"	3·8	2,500	1,900
5·0	1,200	1,000	4·7	3,900	3,800
6·1	2,000	2,600	5·1	4,900	5,800
7·2	3,700	11,400	6·6	6,500	8,200
8·3	5,400	15,000	8·2	7,600	10,900
13·2	11,300	21,500	—	—	—
19·9	12,200	23,200	19·3	10,500	17,900
22·5	12,400	23,800	22·7	10,900	18,800

The annealing must be considered to have been sufficient to restore the drawn wire to its original state (before drawing), but in all probability the annealing took place through the whole mass of the fine wire and only at the surface of the thicker wire. These observations have been confirmed for static cycles by ballistic measurements. The fine wire shows the peculiarity previously observed, that up to $H = 5$ the loss is very small or zero. The induction varies linearly with the field at this stage, and is the same with increasing or decreasing field. For fields slightly stronger, the induction, and at the same time the energy lost, increase abruptly and become very considerable in amount; the effect is either of a chemical nature or depends on the cross-section.

L. H. W.

1118. *Magnetic and Optical Properties of Magnetic Colloids.* O. Scarpa. (Atti dell' Assoc. Elett. Ital. 9. pp. 700-748, Dec., 1905. N. Cimento, 11. pp. 80-118, Jan. and Feb., and pp. 162-185, March, 1906.)—The paper opens with a historical account of the work done in investigating the colloidal state; then follows an account of measurements of the magnetic susceptibility of about twenty inorganic colloids, by a method previously described by the author [see Abstract No. 2272 (1905)]. The magnetic properties of the colloids are expressed in terms of the specific magnetisation, that of the water holding the substance in "solution" being allowed for according to the additive law. Colloids produced by Bredig's method and also those chemically produced are examined, tables of results being given. The magneto-optic rotation is also measured, and Verdet's constant tabulated. The results are discussed in relation to the molecular theory of magnetism; the author considers that he has obtained direct experimental proof of complex molecular groups in the colloidal ferro-magnetic substances. In an appendix are given the results of measurements of electric conductivity, density, and velocity of migration, &c. The colloids of Bredig are all found, from the direction of migration of the ions, to be electro-positive, and all the others except one colloid of ferric hydroxide, electro-negative. S. G. S.

1119. *Effect of Electric Oscillations on Magnetism.* J. Russell. (Roy. Soc. Edinburgh, Proc. 26. pp. 33-47, 1905-1906.)—The author's investigation was made with one quality of sheet iron of large hysteretic constant, the sheet being cut into two crosses, an exploring coil wound round the central square of one cross, and the four arms bent over and placed in coils with two windings (for the magnetising current and the oscillations respectively); the coils were so arranged that either a co-directional or a transverse oscillatory field could be produced. The windings for the oscillations were directly connected to the secondary terminals of a small coil [no spark or spark-gap], and the author assumes that the oscillatory current produced is similar in its magnetic effects to oscillations produced by Hertz waves (?). The results given [in so far as this assumption is justified] supply quantitative data which supplement the qualitative results previously obtained by Marconi, by Walter and Ewing, and by Arnò. Experiments were made with (A) oscillations superposed on constant field, and (B) a change of field superposed on oscillations permanently acting. Under A conditions, at and near extreme cyclic values, the superposition of oscillations produces a large increase of induction for low values of field, and a small increase only with higher fields; with low fields the increase is greater for co-directional, and with high fields for transverse oscillations. The greatest change of induction is obtained with increasing field, and with co-directional oscillations the up curve may cross and reach higher values than the down curve, the curves for the complete cycle forming three loops. B conditions.—For low fields co-directional oscillations increase the permeability more than the transverse; for higher fields the reverse. An induction of a few hundreds is increased to 4 or 5 times greater respectively. When residual magnetism is plotted against field, it is seen that oscillations increase the *relentivity* from low up to high values of induction; the coercive force is increased in low fields. *Hysteresis loss for constant induction.*—When $B_{\max}$ is of order 100-500, oscillations decrease the energy loss 4 or 8 times respectively; a diminution is observed at all fields. *Hysteresis loss for constant field.*—With $B_{\max}$ of order some hundreds the energy loss is increased to about 4 times the loss without oscillations; above this is a neutral point, and higher still ($B = 12,000$) a decrease of energy

loss. As applied to the theory of magnetic detectors, the curves given show the unequal effect produced by oscillations at different parts of the cycle in Marconi's cyclic flux detector: the area of the hysteresis loop obtained when the oscillations act after each step of the cycle is enormously greater than that of the normal loop, and is also greater than when oscillations are permanently acting. The function of the moving field is therefore merely to remove the iron from its preceding cyclic state, and not to increase the sensitiveness. In the moving-band form the effect is considered to be due to the greater increase of induction produced in the band under the left-hand magnet than under the right-hand magnet, if the motion is from left to right; hence the oscillations produce a change of induction in the telephone coil symmetrically placed with reference to the magnets but unsymmetrical with reference to field. The Walter-Ewing form of detector is next dealt with and the essential difference from the Marconi instruments pointed out; the former works under B conditions while the latter work under A conditions. The remainder of the paper contains a criticism of some of Walter and Ewing's results [founded, however, on the author's assumption of certain conditions which were not stated].

L. H. W.

1120. *Elastic Constants and Magnetisation in Wires.* K. Honda and T. Terada. (Physico-Mathematical Soc., Tokyo, Proc. 3. 2. pp. 27-39, March, 1906.)—In former experimental researches [see Abstract No. 2103 (1905)] on kindred subjects, the authors have obtained the relations $\partial e/\partial H$, $\partial E/\partial H$, and $\partial \tau/\partial H$, e being elongation under tension, E =Young's modulus, τ the twist under torsion, and H the field. They now find the relations $\partial I/\partial \phi$, $\partial^2 I/\partial \phi^2$, and $\partial I/\partial L$, where I is magnetic intensity, ϕ the tension, and L is the twisting couple. The theory of these reciprocal relations has been developed by J. J. Thomson, Heydweiller, R. Gans, A. Koláček, M. Cantone, and S. Sano. The authors compare the expressions derived by these several authorities. The expressions for $\partial e/\partial H$ given by Heydweiller, Gans, Koláček, and Sano agree very closely, whilst the values given by Thomson and Cantone differ from those and from one another. And similarly for the other five relations. The experimental values found by the authors are used by them to test these theories. Tables are given showing this comparison. The agreement between theory and experiment is generally fairly good. Remembering the difficulties encountered in measuring the minute strains caused by magnetisation, and the dependence of magnetisation on the order of magnetising, and straining, the agreement is to be considered as fairly good. The best reciprocal relations found are $\partial e/\partial H = \partial I/\partial \phi$; $1/E^2 \cdot \partial E/\partial H = -\partial^2 I/\partial \phi^2$; $\partial \tau/\partial H = \partial I/\partial L$.

P. E. S.

1121. *Magnetic Susceptibility of Manganic Salts.* R. H. Weber. (Ann. d. Physik, 19. 5. pp. 1056-1070, April 10, 1906. Phys. Inst., Heidelberg, Feb., 1906.)—The author, using Quincke's method for measuring susceptibility by means of the "magnetic manometer," finds the following values for the molecular susceptibility of various manganic salts: Manganic phosphate, 0.01084; manganic sulphate, 0.0115; manganese peroxide dissolved in cold concentrated hydrochloric acid, 0.01098. The susceptibility of the manganic salts is less than that of the manganous salts, and intermediate between the values obtained for chromous and manganous salts. [See also Abstract No. 523 (1900).]

T. S. P.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1122. Practical Study of Absorption in Radio-therapy; New Radio-chromometric Telescope. L. Benoist. (*Archives d'Él Médicale*, 14. pp. 260-266, April 10; and pp. 302-304, April 25, 1906.)—In this paper the author describes a method whereby the proportion of Röntgen rays transmitted by, and that absorbed by, a body of given thickness can be determined. When a body is submitted to a beam of Röntgen rays the proportion transmitted by each successive unit of thickness is not constant, but increases at first rapidly, then more slowly, tending towards a constant value. This is because the first units of thickness deprive the beam more and more of the absorbable rays until practically rays of only one kind remain, the transmission of which remains constant. At the same time the radio-chromometric degree of the beam is progressively raised up to a maximum value. Two coefficients are to be obtained. Firstly, the coefficient of mean transmission, that is, the mean fraction transmitted by each successive unit of thickness. From this one may obtain the fraction transmitted by the total thickness by finding the n th root of this fraction, n being the number of units of thickness. Secondly, the coefficient of limit transmission, that is, that which characterises the later units of a thickness sufficiently great to render the selection of a beam finally homogeneous. The author uses a photographic plate enveloped in black paper, on part of which the body to be studied is laid. This is exposed to the rays. On the other portions of the plate known fractions, such as $1/10$, $2/10$, $3/10$, &c., of the total rays are allowed to fall. The plate is then developed, and the tint obtained on the portion which was covered by the body is compared with the different tints corresponding to the known fractions. An apparatus designed for the purpose of facilitating these investigations is described. The latest form of this consists of an optical system forming a telescope of short focus with adjustment for different sights so arranged as to give an enlarged image of the fluoroscopic disc which forms part of the radio-chromometer fixed at the other end of the cylinder of the telescope. The radio-chromometer is on the same principle as that described in a previous paper, and is divided into twelve aluminium sectors of graduated thickness surrounding a central disc of silver. Beyond this there is a diaphragm with an opening which coincides exactly with one sector and the central disc. By rotating this the observer is able quickly to compare the fluorescence produced by the rays passing through the silver disc with that produced by the rays passing through the different sectors, and thus to determine the radio-chromometric value of the output of the tube.

H. W. P. Y.

REFERENCES.

1123. Dust-figures. G. Angenheister. (*Phys. Zeitschr.* 7. pp. 366-367, May 15, 1906.)—Simple arrangement for showing the dust-figures produced on a glass plate strewed with lycopodium under a spark between brass knobs, and the differences brought about by altering the distance between the lycopodium and the spark-discharge. A. D.

1124. Conduction of Liquid Dielectrics caused by Radium. G. Jaffé. (*Journ. de Physique*, 5. pp. 263-270, April, 1906.)—The current, in the case tried, consists of two parts; one obeying Ohm's law, the other a current which can be saturated. Each of these is due to the action of the radium, the first part probably arising from ions of very small mobility.

R. S. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1125. *Regularity of Absorption of Gases in Liquids.* L. W. Winkler. (Zeitschr. Phys. Chem. 55. pp. 844-854, April 18, 1906. Paper read before the Hungarian Academy of Science, Nov. 14, 1904.)—In 1892 the author showed that the coefficients of absorption β of the diatomic gases H_2 , N_2 , CO , NO , O_2 in water were connected with the viscosity μ of water at the same temperature t by the relation $k(1 - \beta/\beta_0) = (1 - \mu/\mu_0)^{2/3}m$, where m is the molecular weight and k a constant, the subscripts denoting values at $0^\circ C$. This formula is justified by renewed experiments which have been made more fully on N_2 , CO , NO , O_2 , and the mean value of k found for these gases in the range 0° to $60^\circ C$. is 8.82. For the pentatomic methane and octatomic ethane the values of k are 2.7 and 2.6 respectively, and graphic extrapolation and interpolation give 4.5, 3.2, 2.9, ... for the values of k when there are 1, 3, 4, ... atoms in the molecule; and examination of the data at hand for argon, helium, hydrogen, bromine, and 9 other gases confirm this result. R. E. B.

1126. *Quartz Glass.* A. L. Day and E. S. Shepherd. (Science, 28. pp. 670-672, April 27, 1906.)—Describes the valuable properties of vitrified silica and the difficulties which are encountered in the attempt to produce clear quartz glass free from bubbles. The present authors have tried the effects of pressure on the fusion of silica, and find that merely increasing the pressure, raising the temperature, or prolonging the time of heating is not sufficient to eliminate the bubbles. The process which they have found successful consists in first rapidly heating the mass of quartz fragments to a very high temperature, about $2,000^\circ C$., thus producing rapid volatilisation of the silica with the purpose of causing the silica vapour to displace the air enclosed between the grains of the charge; a pressure of 500 lbs. is then applied by means of compressed air and the temperature reduced to about $1,800^\circ$ and maintained in this condition for some time, the current being then turned off and the pressure gradually reduced. The process is carried out in a large bomb furnace, the silica being contained in a thin-walled graphite box which is heated by an electric current. The authors have by this process produced blocks of quartz glass measuring $3 \times 5 \times \frac{1}{2}$ in. which are almost entirely free from bubbles and only occasionally slightly stained with free silicon. The residual bubbles are very small and not frequent enough to interfere with the use of the glass for lenses or other optical purposes. The authors consider that with greater experience it will be possible to eliminate the bubbles entirely, and—by the aid of a larger furnace—to produce much larger masses of clear quartz glass. W. Ros.

1127. *Alteration in Properties of the Elements, in particular, of Chlorine.* R. Fabinyi. (Phys. Zeitschr. 7. pp. 63-68, Jan. 15, 1906. Paper read before the Liège Congrès de Radiologie.)—In the preparation of inorganic and organic substances, the order in which the reagents are mixed may alter the properties of the resulting compound. The author finds the same thing to hold in the case of chlorine, which he prepares by adding (1) sulphuric acid to a mixture of potassium dichromate and sodium chloride, and (2) sodium

chloride to a mixture of potassium dichromate and sulphuric acid, the chlorine being afterwards washed and dissolved in water. Chlorine (1) is pale greenish-yellow and its solution pale green, whilst chlorine (2) is dark yellowish-green and its solution dark green. Chlorine (1) is more soluble in water than (2), whilst, under the action of light, the latter solution is the more readily converted into HCl solution than the former. The differences can only be explained by the assumption either of different intramolecular equilibria in the two cases or of subatomic differences conditioned by variations in the splitting off of electrons from the chlorine atoms.

T. H. P.

1128. *New Method for Estimating Metals (especially Gold and Palladium) by means of Conductivity Measurements.* J. Donau. (Akad. Wiss. Wien, Sitz. Ber. 114. 2b. pp. 1169-1180, Dec., 1905. From the Laborat. für allgem. Chemie an der k.k. techn. Hochschule, Graz.)—When a hydrochloric acid solution of gold or palladium chloride is reduced by means of CO an increase in conductivity takes place, by the measurement of which the amount of metal present may be determined. In the case of gold, although the increase is not proportional to the amount of metal contained in the solution, but depends also on the concentration of the hydrochloric acid present, a simple relation exists between these quantities and gives accurate results. With palladium the increase in conductivity is proportional to the amount of metal present. The method gives accurate results when ordinary quantitative analysis fails.

T. S. P.

1129. *Conductivity Measurements on Molten Salts.* K. Arndt. (Zeitschr. Elektrochem. 12. pp. 387-342, May 4, 1906. Communication from the elektrochem. Laborat. d. techn. Hochschule, Berlin.)—Conductivity measurements, using the method of Kohlrausch, were made on a number of molten salts, viz., KCl, NaCl, CaCl₂, SrCl₂, BaCl₂, K₂SO₄, Na₂SO₄, K₂CO₃, Na₂CO₃, commercial CaCl₂. In order to obtain a resistance great enough to give a good minimum in the telephone a special form of U-tube, made of porcelain, was used as the conductivity vessel. The conductivities were measured in each case over a range of temperatures above the melting-point. The temperature coefficient is small, and in most cases it decreases with increase in temperature. The conductivities (specific) conform to the formula—

$$K = a[1 + b(t - 900^\circ) - c(t - 900^\circ)^2],$$

where a is the conductivity at 900° , and b and c are empirical constants. In the case of KCl and NaCl the conductivity is proportional to the absolute temperature and is given by the equations $x_{\text{KCl}} = 0.00208T$, $x_{\text{NaCl}} = 0.00812T$ respectively; a similar equation does not hold for the other salts. The author also gives a table of the melting-points of the various salts.

T. S. P.

1130. *Liquid Carbon Dioxide as Solvent.* E. H. Büchner. (Zeitschr. Phys. Chem. 54. pp. 665-688, March 13, 1906. Anorg. chem. Laborat. d. Univ., Amsterdam, Oct., 1905.)—The various organic and inorganic substances examined are divided into three classes, according to their behaviour towards liquid CO₂: (1) Those which are completely soluble in the liquid state and give a solubility curve below the critical line. (2) Those with which the solubility curve cuts the critical line. (3) Those exhibiting limited solubility. Volatile substances (excepting water and alcohols) appear to be soluble in all

proportions in liquid CO_2 , those which are only slightly volatile or non-volatile being in general insoluble. Corresponding with the position of the melting-point, either the solid substance remains along with the solution in CO_2 , or else a second liquid layer is formed; the first case is generally met with in compounds having melting-points higher than about 60° , and in such systems we then find a critical temperature of the saturated solution. The type of demixing with a lower critical point—previously regarded as rare—is often observed with CO_2 . Several examples are given with which a lower critical point appears with supercooled liquids. Liquid CO_2 differs greatly from other condensed gases, such as ammonia and SO_2 , which readily dissolve inorganic salts, or HCl , HBr , HI , H_2S , in which many organic substances are readily soluble. It resembles more nearly liquid cyanogen, which also exhibits only a very low conductivity. T. H. P.

1131. *Changes of Condition in Liquid Sulphur.* F. Hoffmann and R. Rothe. (Zeitschr. Phys. Chem. 55. pp. 113–124, March 20, 1906. Phys.-Techn. Reichsanstalt, Charlottenburg, Abt. II., Dec., 1905.)—Fused sulphur at a temperature of about 160° changes from a thin to a viscous liquid. At times the transition takes place abruptly and is accompanied by a sharp change of temperature. During cooling the liquid breaks up into two parts, distinctly separated by a meniscus; with rising temperature this does not take place. This example of coexisting liquid phases is unique, but is not completely analogous with an ordinary case of transformation. When the change of temperature is slow the separation of the phases become less distinct, and under some circumstances no separation into two layers and no thermal irregularity occur. With rising temperature the transformation-point, the melting-point, and the point at 160° are marked on the curve; with falling temperature only the last two. The point mentioned was found by a thermoelectric method to be at 160.6° with rising temperature; at 159.8° with falling temperature. Stirring obliterates the abrupt change of temperature; nevertheless, it is impossible to suppose that the formation of a meniscus depends only on mechanical causes such as convection currents and the like. It is possible that there are in liquid sulphur two different polymers, differing in viscosity and colour, which are completely miscible when they are in equilibrium, but are possibly not so when in the labile condition, that is, when the reaction takes place more slowly than the change of temperature. We may also assume that from a certain point the velocity of solution is smaller than the velocity of transformation; in the former case the temperature in question must lie in the immediate neighbourhood of the critical point of solution of both polymers; the very small difference in the colour of the two layers supports this supposition. The experimental work was conducted with the registration galvanometer described in Abstract No. 2287 (1905), in conjunction with a thermoelement. When a copper-constantan couple was employed, as was usually the case, the sensibility at about 150° amounted to 0.4° for a deflection of 1 mm. D. H. J.

1132. *Sodium-Aluminium, Sodium-Magnesium, and Sodium-Zinc Alloys.* C. H. Mathewson. (Zeitschr. Anorg. Chem. 48. 2. pp. 191–200, Jan. 2, 1906. Metallog. Contribution from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—At the melting-point of aluminium sodium and aluminium are not perceptibly soluble in one another. There are formed two practically pure immiscible liquid layers. Sodium and magnesium give, on the other hand, two liquid layers in which both metals are contained. On addition of

Na the melting-point of Mg is lowered from 650° to 688° . The melted Mg dissolves Na up to 2 per cent. At 657° , 1.6 per cent. of Mg dissolves in Na. Sodium and zinc form two liquid layers, and also a compound, NaZn_{11} or NaZn_{12} . Of the two liquid layers, the one rich in Na contains very little Zn, whilst at 557° there are about 6 atomic per cent. of Na dissolved in the liquid phase which is rich in Zn. F. G. D.

1133. *Anti-friction Metals having Lead or Tin Bases.* S. Kern. (Chem. News, 98, p. 47, Feb. 2, 1906.)—A specially effective babbit, used by a large works for heavy marine bearings, containing 72 Pb, 21 Sn, and 7 Sb per cent., melting at 225° and freezing at 242° C., superseded others having larger liquation ranges. All such alloys with lead base are found to have greater liquation ranges than those with a tin base, and analysis shows their composition to be comparatively irregular. A moderate amount of lead is desirable, however, in tin-base babbits—it has a lubricating effect, and aids in the alloying of Sn and Sb. The author prefers the following: Sn, 84; Sb, 2.15; Pb, 6.25; Cu, 7 per cent., melting at 225° and solidifying at 221° C., leaving only 4° for liquation effects. F. R.

1134. *Equilibrium Curves of the Iron-Carbon System.* H. v. Jüptner. (Iron and Steel Mag. 11, pp. 377–382, May, 1906.)—From the observations of the solidification of iron-carbon alloys recorded by Mannesmann and Osmond, Roberts-Austen, Carpenter and Keeling, and Wüst, and assuming the melting-point of pure iron to be $1,550^{\circ}$ C., the author calculates the most probable equilibrium curves for the solid and fluid phases. The eutectic lies at about 4.8 per cent. carbon, and the end of the eutectic line at 2.07 per cent. carbon—almost exactly where Roozeboom presupposed it. Using the Rothmund formula, it is estimated that if the latent heat of fusion of iron be 20 calories, the molecule of carbon dissolved in fluid iron contains two atoms, or if the latent heat be 40 cal., the molecule is monatomic. F. R.

1135. *Etching Method for Identification of Crucible Steel.* J. A. Aupperle. (Iron and Steel Mag. 11, pp. 383–385, May, 1906.)—It is not possible to differentiate Bessemer and open-hearth from crucible steel with certainty from their compositions. Even the amount of oxygen present—in addition to the fact that its determination in works' routine is impracticable—is not a sure guide, as the maximum in crucible steel overlaps the minimum in Bessemer or open hearth. Incidentally the author mentions experiments in which Bessemer steel which contained 0.12 per cent. oxygen before addition of ferro-manganese, contained only 0.08 per cent. finally. The etching method consists of immersing $1\frac{1}{2}$ in. square specimens in a solution of, for each specimen, 90 c.cm. water, 10 c.cm. H_2SO_4 , and 3 grains [(?) gm.] permanganate of potash; allowing to stand overnight, then boiling to remove colour, if any, due to Mn compounds, adding acid if necessary. To the naked eye Bessemer and open-hearth steels will be found etched in grooves, and rough at the edges; crucible steels will be comparatively smooth, showing a close structure, with at most an appearance of minute pittings. Photographs of the two types are given. F. R.

1136. *Cementation Process.* A. Ledebur. (Stahl u. Eisen, 26, pp. 72–75, 1906.)—As opposed to Guillet's view that cementation occurs through the action of gaseous compounds of carbon, especially cyanides, arising from the alkali in the ashes of the charcoal used, and the nitrogen of the atmosphere

[see Abstracts Nos. 794B, 1018B, and 1985B (1904)], the author upholds the older view that cementation occurs by direct action of solid carbon upon the iron. He cites experiments in which bars of Lancashire iron containing 0.144 per cent. carbon were heated at a temperature not exceeding 950° C. for 408 hours, in fresh wood charcoal (ash 2.0 per cent.), in previously used wood charcoal (ash 10.75 per cent.), and in sugar charcoal which had been exhausted with acid, and whose ash (0.75 per cent.) contained no alkali. The carbon contents after cementation were 1.45, 1.23, and 1.38 respectively. The high ash of the used charcoal arises partly from the fact that part of the carbon has of course been removed; but it also contains sand and firebrick dust from the box; these form fusible glazes with the alkali, and hinder contact of the charcoal and iron—hence the slower cementation. Guillet states that too high a temperature in case-hardening causes decarburisation, but the author considers that this will not occur if the supply of carbon be maintained and access of air prevented. F. R.

1137. Solubility of Copper in Iron and Iron-Carbon Alloys. V. O. Pfeiffer. (Metallurgie, 8, pp. 281-287, May 8, 1906. Communication from the eisen-hüttenmänn. Inst. der kgl. techn. Hochschule, Aachen.)—Describes an investigation, by means of cooling-curves and microstructure examinations of mixtures of molten copper both with pure iron and with iron containing various proportions of carbon. The conclusion is arrived at that there is no true solubility of copper in molten iron or iron-carbon alloys; the experimental evidence for this conclusion is found in the facts that the cooling-curves of the mixtures in question do not differ from those of similar metal in the absence of copper, except that with increasing copper content the freezing-point of pure copper becomes increasingly prominent. The absence of any effect upon the freezing-point of the metal is regarded as the criterion of the non-formation of a true alloy, as distinguished from an emulsion or suspension. Examination of the microstructure confirms the evidence of the mutual insolubility of iron and copper, the structures found being consistent only with the presence of the copper in the molten metal in a state of suspension, and consequently in the solid metal as mechanical enclosures. No signs of the existence of mixed crystals or eutectics are found. The author thus considers that there are no true iron-copper or iron-carbon-copper alloys, the effects of the presence of copper in more or less finely divided suspension alone giving rise to the mechanical and other properties associated with its presence in iron. W. Ros.

1138. Separation of Silver from Silver Sulphide in Presence of Mercury. F. W. Hinrichsen and T. Watanabe. (Wüllner Festschrift, pp. 214-216, 1905. Chem. Centralblatt, 2, pp. 1642-1644, 1905.)—An attempt to elucidate the function of mercury in the Patio and Kröhnke amalgamation processes. By agitating mercury and silver sulphide together in the proportion of 11.5 to 1, distinct quantities of silver are removed from the sulphide, increasing with duration of the experiment, but practically independent of temperature between 15° and 40°. In the presence of water, less silver sulphide is decomposed, due probably to the decrease in adhesion of mercury caused thereby, and the reaction is then materially increased by rise of temperature. When zinc amalgam is substituted for mercury at 40°, the components mix completely, forming a tough mass but no silver amalgam. No appreciable mercurous chloride is produced when a saturated solution of

sodium chloride is shaken with mercury either at the ordinary temperature or on boiling, and only very slight decomposition of silver sulphide by sodium chloride can take place owing to the very sparing solubility of silver chloride. The conductivity of a solution of sodium chloride containing 64 gm. per litre is not affected by the addition of silver sulphide, but when the latter is added to a 20 per cent. solution of sodium chloride the filtrate gives a precipitate of silver sulphide on addition of ammonium sulphide. Experiments on the quaternary system: silver sulphide, mercury or zinc amalgam, sodium chloride, and water, at 14° and 40°, show that decomposition is aided by rise of temperature or increase in quantity of sodium chloride in solution. When a piece of silver-foil, coated with silver sulphide by immersion in warm ammonium sulphide solution, and a rod of zinc, are placed in a solution of sodium chloride and connected, silver is deposited on the latter and zinc sulphide is formed. Zinc amalgam and mercury give better results than mercury alone, though at 40° the increase of the yield is only apparent with more concentrated solutions of sodium chloride. Zinc amalgam does not appreciably attack silver sulphide in water, but decomposes forming zinc hydroxide. The e.m.f.'s of zinc-silver sulphide and iron-silver sulphide couples immersed in a 20 per cent. solution of sodium chloride are 0.965 and 0.86-0.44 volt respectively, hence iron cannot liberate silver from silver sulphide in a sodium chloride solution. Decomposition of silver sulphide by mercury in presence of sulphuric acid or potassium cyanide is considerably increased by adding a piece of iron or glass, the effect being largely due to change of mechanical conditions. When mercury is shaken with sodium chloride solution small globules are formed, but with potassium cyanide the metal retains a continuous smooth surface. The action of zinc amalgam on silver sulphide in sodium chloride solution is increased by adding more zinc, and the tendency of the amalgam to form globules becomes less. A similar effect is produced by increasing the quantity of mercury, the surface of contact being enlarged. The amount of silver separated from silver sulphide by treatment with iron in potassium cyanide solution is proportional to the concentration of the cyanide. W. H. St.

1139. *Rusting of Iron.* G. T. Moody. (Chem. Soc., Journ. 89, pp. 720-780, April, 1906.)—The experiments on the rusting of iron which were carried out by Dunstan, Jowett, and Goulding [see Abstract No. 193 (1906)] are invalidated because these investigators did not take sufficient care to exclude CO_2 . The author shows that iron does not rust in the presence of oxygen (air purified from CO_2) and water alone; the admission of CO_2 causes rapid rusting to occur. The composition of rust in the course of formation is found to be quite different from $\text{Fe}_2\text{O}_3(\text{OH})_2$ (Dunstan's formula); it always contains ferrous oxide and carbonate, and this is altogether out of harmony with the view that H_2O_2 is an effective agent in its production. Iron is quite indifferent towards pure H_2O_2 . Solutions of CO_2 in water are found to rapidly attack iron; if iron is put into distilled water which has been shaken up with air it can be detected in solution after 40 sec. Rusting is thus due to the ready interaction of iron and moist CO_2 , resulting in the formation of hydrogen and ferrous salts, followed by more or less complete oxidation of ferrous salts by atmospheric oxygen. T. S. P.

1140. *Precipitation of Colloidal Solutions by Centrifugal Force.* W. S. Franklin and L. A. Freudenberger. (Amer. Electrochem. Soc., Trans. 8, pp. 29-31; Discussion, pp. 81-82, 1905.)—The authors subjected colloidal

solutions of platinum and of Prussian blue to the action of centrifugal force, and found that with an acceleration at the end of the tube of 1,200-1,500 times that of gravity precipitation of the colloid could be produced. In the discussion, J. W. Richards considered that the results pointed to the colloidal solutions being suspensions, but one of the authors (Franklin) thought that this was not necessarily the case. He considered it possible that a condition of supersaturation was produced which caused the coagulation to start, and that thus the coagulation spread through the tube. There was no evidence of the formation of a stable state of equilibrium with a greater degree of concentration at one end of the tube than at the other, as in the case of gases. A. F.

1141. *Calculation of Chemical Equilibrium from Thermal Data.* W. Nernst. (Gesell. Wiss. Göttingen, Nachr., Math-Phys. Klasse, 1. pp. 1-40, 1906.)—The equilibrium of gaseous substances is first considered. A chemical reaction being given by $\sum \nu A = \sum \nu' A'$ and the reaction occurring from left to right when heat is evolved, it is assumed that the equilibrium-concentrations c obey the mass law $\log K = \sum \nu \log c - \sum \nu' \log c'$ with $Q = RT^2(\partial \log K/\partial T)_V$, where Q denotes the evolved heat and V the total volume. Q being taken of the form $Q_0 + T \sum \nu a + T^2 \sum \nu \beta + \dots$, this gives—

$$R \log K = RJ - Q_0/T + \log T \sum \nu a + T \sum \nu \beta + \dots$$

where J is the constant of integration that has to be determined. Haber takes $J=0$, but here certain reasoning gives $J = \sum \nu i$, where i is the integration-constant, peculiar to each substance, that occurs in the relation $R \log \xi \doteq Ri - \lambda_0/T + (a - a_0) \log T + (\beta - \beta_0)T + \dots$, by which the two-phase equilibrium-concentration ξ is given. Furthermore, the equations $\partial E/\partial T = 2T \sum \nu \beta_0 = -\partial W/\partial T$ follow, where E is the intrinsic energy and W the maximum work obtainable from the chemical process. The case of saturation is then considered, especially in reference to hydrogen, argon, nitrogen, oxygen, carbon dioxide, chloroform, ammonia, hydrogen chloride, water, and ether, for the determination of the constants i or rather of the related constants $C \equiv (i + \log R)/2.808$, and then the circumstances of the dissociation of water vapour and carbonic acid and of the formation of nitric oxide, hydrogen chloride and ammonia together with some heterogeneous systems are discussed. The stability of chemical compounds, the equilibrium for the gas-solid phases, the melting- and transformation- points are finally considered. The author's conclusion is that the exact calculation of chemical equilibrium from thermal data is possible if the curves of the free and total energy of chemical reactions between solid bodies or liquid bodies touch each other at absolute zero temperature. R. E. B.

1142. *Osmosis and Osmotic Pressure, with Observations concerning Dialysis.* L. Kahlenberg. (Journ. Phys. Chem. 10. pp. 141-209, March, 1906.)—The author first discusses the part played by the semi-permeable membranes in osmotic experiments, and strongly supports the view, now generally adopted, that the action of the membrane depends on selective solubility. Since all degrees of solubility can occur, it is evident that a particular membrane may also exhibit all degrees of semi-permeability; the condition for true semi-permeability being that the membrane dissolves the solvent, but not the solute. If neither solvent nor solute dissolves in the membrane, osmosis cannot occur. A large number of qualitative experiments are communicated

showing the action of different membranes with different solutions, by which the above standpoint is illustrated. Quantitative measurements have also been made using caoutchouc membranes and solutions of cane-sugar, lithium chloride, and silver nitrate in pyridine. In these cases the membrane is practically semi-permeable. In his first experiments the author failed to obtain concordant results, but found later that if the solutions and also the surrounding solvent are stirred much more concordant results are obtained. The absolute values of the pressure obtained are also very considerably greater. As a result, the author concludes that the gas laws do not hold at all for solutions, neither with regard to concentration nor temperature; and the theory of electrolytic dissociation is rejected by the author because solutions of lithium chloride give lower pressures than solutions of cane-sugar. With regard to the process of dialysis, the author again emphasises the importance of the membrane used, as by properly selecting this a separation can be effected not only of colloids from crystalloids, but also of crystalloids from each other; and the separation may take place owing to the colloid passing through the membrane and leaving the crystalloid behind, or by the crystalloid, or one of the crystalloids, passing through the membrane. A. F.

1143. *Distribution of Organic Acids between Two Solvents.* W. Herz and M. Lewy. (Zeitschr. Elektrochem. 11. pp. 818-820, Nov. 17, 1905. Chem. Inst. d. Univ., Breslau, Oct. 30, 1905.)—If the molecules are of equal size in the organic solvent and in water, the ratio of distribution L/W (L = solvent, W = water) should be constant, but if the acid is polymerised the constancy of the ratio L/W indicates the degree of association. In this way evidence was obtained that in the case of acetic acid double molecules exist in all organic solvents at low concentrations, but in concentrated solutions the factor of association appears to rise to 4 or 5. In the case of chloroacetic acid the closest agreement is obtained with a factor of association of 8 in chloroform and bromoform, and 5 in carbon disulphide and carbon tetrachloride. Picric acid in chloroform or bromoform appears to give double molecules which are dissociated as the concentration decreases. T. M. L.

1144. *Electrolytic Phases in Metals.* C. E. Fawsitt. (Roy. Soc. Edinburgh, Proc. 28. pp. 2-6, 1905-1906.)—Differences in all the various states of metals are explained by the fact that solids exhibit two distinct phases, the amorphous or vitreous, and the crystalline [see Beilby, Abstracts Nos. 1588B and 2506B (1904)]. These differences are very often great, and they led the author to examine the p.d. between the two phases of a metal in an electrolyte. He found that the potential of the metal in the amorphous phase is negative, and in the crystalline phase positive, when the two kinds of metal are placed in a solution of a salt of the metal. If two silver rods are immersed in a solution of silver nitrate, after having been kept at a red-heat for several hours, the cell has no e.m.f. If one of the rods is polished or hammered, it acquires a greater tendency to dissolve, and it therefore becomes the negative pole of the cell, the p.d. being about 0.012 volt. The e.m.f. is brought back to zero by prolonged heating. Gold gives about double the e.m.f. of silver when one rod is polished or hammered. This is abolished by annealing, or by dissolving away the vitreous polished layer with aqua regia. Polished platinum in solution of platinum chloride is also a negative pole with respect to annealed platinum. E. E. F.

1145. *Iodine-potential and the Ferri-ferro-potential.* W. Maitland. (Zeitschr. Elektrochem. 12. pp. 263-268, April 6, 1906. From the chem. Universitätslaborat., Breslau.)—Two different values are generally given for the potential of iodine, one for the saturated solution (A_1), and the other for the normal solution (A_2). A saturated solution at 25° containing 0.013 mol. per litre, the difference between the two values is 0.0849 volt. Determinations of these magnitudes by measuring the potentials of platinum electrodes against the normal calomel electrode in solutions of varying content of iodine and potassium iodide lead to the value 0.2569 volt for A_1 and 0.3418 for A_2 , both at 25° . These values can be controlled by means of the ferri-ferro-potential, which is found to have the value $0.460 + 0.0591 \log [(Fe^{+++})/(Fe^{++})]$ when measured against the normal electrode at 25° . In equilibrated solutions, obtained either by reducing ferric salts by potassium iodide or by oxidising ferrous salts by iodine, the potential of a platinum electrode must be given both by the quotient Fe^{++}/Fe^{+++} and by I_2/I^{-2} . Both of these quotients being determinable analytically, comparison of the calculated with the observed potential gives a control of the normal potential, as expressed by the equations—

$$\log [(Fe^{++})/(Fe^{+++})] = (0.460 - e)/0.0591 \text{ and } \log [(I_2)/(I^{-2})] = (e - 0.3415)/0.02955.$$

The agreement obtained is a good one. T. H. P.

1146. *Electricity Carriers produced by Falling Liquids.* E. Aselmann. (Ann. d. Physik, 19. 5. pp. 960-984, April 10, 1906. Extract from Inaug. Dissertation, Kiel.)—The carriers were produced by the fall of water and of solutions of common salt. The experimental arrangement was chiefly that of Kähler, and measurements were made by a quadrant electrometer; on account of the differences in the mobility of the carriers produced, both from the distilled water and the salt solutions, two different appliances (net and cylinder condensers) were necessary for the measurement of the migration velocities. The chief results of the experiments may be summarised as follows: (1) Kähler's result that distilled water yields only negative carriers, common salt solutions both negative and positive carriers simultaneously, was confirmed; (2) the mobility of carriers of one and the same sign is not uniform; (3) in the original paper a table is given of the limits for the velocity of migration of the gas carriers and for the sums of the diameters of gas carriers and gas molecules. The gas carriers are complexes (up to 200 diameters) of air molecules; (4) in the case of sodium chloride solutions, small drops of the solution are formed and float in the air; these small drops soon dry up, leaving a fine dust of salt particles of the average diameter $\sqrt{n}6 \times 10^{-6}$ cm., where $n = 1, 2, 3$, or perhaps more; (5) 1.5×10^{-8} mgm. of sodium chloride is sufficient to impart a visible yellow colour for 1 sec. to a Bunsen flame placed in the dark. D. H. J.

1147. *Electrical Production of Ozone.* A. W. Ewell. (Phys. Rev. 22. pp. 232-244, April, 1906.)—A new form of ozoniser has been devised and its efficiency compared with previous types. Warburg has obtained a yield of 27 gm. per kw.-hour with one electrode pointed and the other a plane, the points being positive, and 13 gm. per kw.-hour with points negative or alternating. The yield of the present form is considerably over 70 gm. The author finds the best conditions are: an alternating current, a silent discharge, interposition between the electrodes of a very thin sheet of dielectric,

and that the air should be under the influence of the discharge for a very short time, to avoid the deozone effect. The last condition is fulfilled by having a large gas velocity, and making the electrodes thin strips of metal placed so that the air moves parallel to their shortest side. R. S. W.

1148. *Phenomena of Metal Depositing.* A. G. Betts. (Amer. Electrochem. Soc., Trans. 8. pp. 68-96; Discussion, pp. 96-99, 1905.)—A series of notes relating to the various circumstances that effect the nature of an electrodeposited metal. The influence of colloids, strength of acid, valency, alkalinity of base, temperature, tendency to crystallise, basic salts, purity, surface tension, electrode-effect, differences of concentration, high potential, and difference between the solution and electrode is discussed. Electrodeposits are divided into three classes: (1) smooth and tenacious, (2) branching, and (3) slimy or spongy; and the following table is given:—

Metals deposited in Solid Form.

Cu from sulphate solution.
Zn from sulphate solution.
Ni from sulphate solution.
Co, Bischoff and Tiemann's process.
Cr from chromic acid, Carveth and Curry.
Fe from slightly acid sulphate solution, Betts.
Sb from SbF_3 , Betts.
Au from AuCl_3 , Wohlwill's process.
Pd from palladium ammonium chloride, Cowper-Coles.

Metals producing Loose Deposits.

Ag from AgNO_3 .
Cd from CdSO_4 .
Pb from lead fluosilicate, acetate, nitrate, &c.
Sn from SnCl_2 .
Tl from thallium hydroxide, Marsh's storage cell.

W. W. H. G.

1149. *Chemical Effects of the Silent Discharge.* W. Löb. (Zeitschr. Elektrochem. 12. pp. 282-312, April 18, 1906.)—The author calls his apparatus an electrator. The silent discharge passes between two concentric tubes of glass—some experiments made with uviol glass gave substantially the same results—through an annular space, 2 mm. in width; the tubes are filled with sulphuric acid, into which the electrodes of an induction apparatus are dipped. Alternating currents do not produce any ozone from air in such an apparatus, as Kreisler had already observed. When the space is charged with CO_2 and water vapour, direct-current discharges yield CO, formic acid, H_2O_2 , O, and some ozone; further, after some time, formaldehyde, while H_2O_2 is at once observed. The reactions are complicated. The CO reacts with H_2O , giving CO_2 and H_2 ; the hydrogen is peroxidised by the ozone, and this latter reaction is more rapid than the splitting up of water by the CO; a little ozone is finally found but hardly any hydrogen. When some hydrogen is added to the gas mixture from the beginning, the yield of formaldehyde is increased. With alternating currents H_2O_2 and ozone are not produced, and their formation seems to be interconnected. Other mixtures experimented with are CO and water; CO_2 , water, and some substance which will absorb the oxygen liberated—more formaldehyde and formic acid are then obtained; CO, water, and hydrogen, in this last instance some glycolaldehyde is found which can easily be transformed into sugar (Fenton). Thus sugar can be prepared by the silent discharge from CO_2 and water. In some cases methane was also observed, and the most interesting

final products are either glycolaldehyde or acetaldehyde. These reactions take place only in the gases and vapours, not when the silent discharge is sent through aqueous solutions. The temperature in the electrator did not rise above 40° C. In the further experiments with vapours of ethyl alcohol, acetaldehyde, and acetic acid, the electrator had to be heated. References are made particularly to Losanitsch and Jovitschitsch, whom the author on the whole confirms, and to de Hemptinne. H. B.

1150. *Electrolytic Preparation of Iodoform from Acetone.* G. A. Roush. (Amer. Electrochem. Soc., Trans. 8. pp. 281-286, with Discussion, 1905).—When a solution containing potassium iodide and acetone is electrolysed without a diaphragm, 2 mols. of alkali are liberated per 1 of iodoform, whilst with a diaphragm 4 mols. of acid are formed per 1 of iodoform. The author combines these two electrolyses in such a way that the acid freed in the one rather more than neutralises the alkali liberated in the other, thus obtaining a faintly acid solution, which is the most favourable for the formation of iodoform. A rotating platinum anode is used in conjunction with two kathodes, a "regular" one consisting of a platinum wire immersed in the electrolyte, and an "auxiliary" one dipping into a porous cup also containing the electrolyte. By adjusting the resistances connected separately with these two kathodes, the current passing through the auxiliary kathode can be made equal to about two-thirds of that traversing the regular kathode, the solution being thus kept slightly acid. The current efficiency, under these conditions, is about 95 per cent., and the acetone yield of iodoform about 75 per cent. T. H. P.

1151. *Electrical Phenomena accompanying the Decomposition of Ammonium.* A. Coehn. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 100-109, 1906. Inst. f. phys. Chemie, Göttingen, Jan. and Feb., 1906).—When the metal ammonium, the existence of which has been previously proved by the author, decomposes into the non-metals ammonia and hydrogen, a suppression of the dissociation of the electrons within the substance takes place. If this occurs suddenly, electrons should escape and cause effects similar to those produced by radio-active substances. By an appropriate arrangement in connection with a quadrant electrometer of the Dolezalek pattern, it is shown that when ammonium amalgam, produced by the electrolysis of a solution of an ammonium salt, decomposes, it gives out positive particles, and becomes negatively charged itself to the extent of 7 volts. The expulsion of positive particles is accelerated by charging the amalgam positively, and hindered by a negative charge. Rise in temperature exerts an influence, in that it increases the velocity of decomposition of the amalgam. The effect is shown not to be due to vapours of ammonia, nor to gas-bubbles which may escape from the surface of the amalgam. A mixture of ammonia and hydrogen bubbling through mercury does not produce any effect. Sodium and potassium amalgams do not behave in a similar manner; if, however, these amalgams are dipped into a solution of an ammonium salt, thus producing an ammonium-potassium or ammonium-sodium amalgam, an effect is produced, but not nearly so marked as with the pure ammonium amalgam. T. S. P.

1152. *Silver Dioxide and Peroxynitrate.* E. R. Watson. (Chem. Soc., Journ. 89. pp. 578-583, April, 1906).—Electrolysis, with platinum electrodes, of silver nitrate solutions containing 5 and 15 per cent, silver nitrate, employ-

ing a current density of 0.015 — 0.14 amp. per sq. cm., has given in all cases a uniform black anodic deposit, which, crystallising in octahedra, and containing approximately 80 per cent. Ag, is identical with the silver peroxynitrate described by Sulc. Treated with water, the product slowly evolves oxygen at 27–32°, and is completely decomposed on boiling for 1 hour, the reaction being represented by $\text{Ag}_2\text{NO}_3 = \text{AgNO}_3 + 8\text{Ag}_2\text{O}_2 + \text{O}_2$. The dioxide is an insoluble greyish black powder, of sp. gr. about 7.44. Its chemical properties and behaviour are described. The peroxynitrate and oxide of silver, and the peroxysulphate obtained by electrolysis of aqueous silver sulphate solution all dissolve in cold strong nitric and sulphuric acids, the solutions in the former being intensely brown, and in the latter olive-green, the colours and absorption spectra of the solutions from the three substances being identical. The colours are attributed to the formation of peroxy-salts. W. H. ST.

1153. *Influence of Organic Colloids on Electrolytic Deposition of Copper.* E. Müller and P. Bahntje. (Zeitschr. Elektrochem. 12, pp. 817–821, April 20, 1906. From the Elektrochem. Inst. d. techn. Hochschule, Braunschweig.)—The apparent improvement of galvanic deposits by the addition of certain organic compounds to the electrolyte, as more recently studied by Senn and by Snowdon [see Abstracts Nos. 1150 and 1862 (1905)], is, in the author's opinion, a colloidal effect. When deprived of its electric charge at the kathode, the copper is at first in the colloidal state, and the organic colloid present forms a protective coating for it, so that a complex colloid is electro-endosmatically pressed upon the kathode. The authors arranged five identical copper sulphate troughs in series, and added gelatine, egg albumen, gum (arabic?), and starch to the baths. The gelatine made the kathode look as if beads of molten copper had run down the plate; with proper concentration of the gelatine and current density the whole deposit became uniformly lustrous. This copper is, however, brittle; it contains some organic matter, and its density is reduced, e.g., from 8.68 to 8.40 and even 8.19. An experiment is described indicating that the gelatine travels to the kathode in water acidulated with sulphuric acid, and to the anode in alkaline water—the authors seem to believe that only the latter fact had been observed; but an analogous experiment with colloidal copper could not be made. It is, however, noteworthy that the addition of gelatine influences only acid copper sulphate solutions; there is no effect on the weakly alkaline copper cyanide baths. Albumen behaves like gelatine; the effect of gum and starch is less marked.

H. B.

REFERENCES.

1154. *Conditions for the Precipitation and Solution of Metallic Sulphides.* G. Bruni and M. Padoa. (Accad. Lincei, Atti, 14, pp. 525–528, Nov. 19, 1905.)—From considerations of mass action Ostwald concluded that sulphides like zinc sulphide might be precipitated from dilute acid solution by sulphuretted hydrogen if the latter were under pressure. Experimental proof of this is here given for the first time in the case of ferrous, cobalt, nickel, zinc and cadmium salts. D. H. J.

1155. *The Equilibria $6\text{H}^+ + 5\text{I}^- + \text{IO}_3^- \rightleftharpoons 3\text{I}_2 + 3\text{H}_2\text{O}$, and $6\text{H}^+ + 5\text{Br}^- + \text{BrO}_3^- \rightleftharpoons 3\text{Br}_2 + 3\text{H}_2\text{O}$ determined Chemically and Electrochemically.* V. Sammet. (Zeitschr. Phys. Chem. 53, pp. 641–691, Dec. 22, 1905.)—The equilibrium constant in the second reaction could not be determined chemically, but was determined electrochemically and found $K_{298} = 0.78 \times 10^{-38}$. The paper also contains measurements of solubilities and conductivities of the substances involved. A. F.

1156. *Equilibria in Silver Chloride Solutions.* R. C. Wells. (Journ. Phys. Chem. 10. pp. 79-92, Feb., 1906.)—The author has shown, by means of nephelometric measurements, the constancy of the solubility product for silver chloride. He concludes from the experiments that the mass law, like many other physico-chemical laws, approaches exact fulfilment at great dilution, even when applied to ionic concentrations of strong electrolytes.

1157. *Influence of Temperature and Concentration on the Specific Rotatory Power of Optically-active Substances.* I. H. Grossmann and L. Wieneke. (Zeitschr. Phys. Chem. 54. pp. 385-427, Jan. 30, 1906.)—The curves connecting specific rotation and concentration of solution of tartaric acid are approximately parallel and rectilinear for temperatures from 0° to 90°, the same is the case for malic acid. Results are given of experiments indicating the influence of pyridine and boric acid on the rotations of these compounds, and the complexes formed are discussed.

T. H. P.

1158. *Molecular Potential of the Constituents of a Normal Binary Mixture in the Liquid State.* J. J. van Laar. (Archiv. Musée Teyler, 10. 1. pp. 45-58, 1905.)—A mathematical paper unsuited for abstraction.

A. F.

1159. *Mixed Crystals in Ternary Systems.* F. A. H. Schreinemakers. (Zeitschr. Phys. Chem. 51. pp. 547-576, April 25, and 52. pp. 513-550, Aug. 8, 1905. Archives Néerlandaises, 11. pp. 53-114, 1906.)—The discussion applies equally to amorphous or all substances which show a change in composition with that of the solution with which they are in equilibrium. The author divides crystals into four principal types with many subdivisions. It appears that the temperature of eutectic solidification of two bodies rises or falls as the mixture contains a smaller or larger proportion of the third substance than the corresponding complex. A very complete discussion is given of the isotherms of Type I.

H. H. F. H.

1160. *Displacement of the Equilibrium of Univariant and Bivariant Systems.* P. Saurel. (Journ. Phys. Chem. 10. pp. 108-118, Feb., 1906.)—The general thermodynamic equations which connect the simultaneous changes in the temperature, pressure, and concentrations of the phases of a system as it passes from one state of equilibrium to another are here applied to the particular cases of univariant and bivariant systems having any number of components. The results obtained include as special cases the formulae obtained by van der Waals and by Trevor for binary and ternary systems.

F. G. D.

1161. *On Solubility Curves.* J. E. Trevor. (Journ. Phys. Chem. 10. pp. 99-107, Feb., 1906.)—In this paper an expression for the slope $dm_1/d\theta$ of the solubility-curve, $m_1 = m_1(\theta)$, of a two-component system in a three-phase state is obtained from the general thermodynamic conditions of equilibrium. The symbol m_1 denotes the mass of component (1) contained in unit mass of phase (1).

F. G. D.

1162. *Solubility of Mercuric Chloride in Ethyl Acetate and Acetone.* A. H. W. Aten. (Zeitschr. Phys. Chem. 54. pp. 121-123, Dec. 22, 1905.)

A. F.

1163. *Hydrolytic Decomposition in Non-aqueous Solutions.* G. Bruni and A. Manuelli. (Zeitschr. Elektrochem. 11. pp. 554-555, Aug. 25, 1905. From the allgem. chem. Inst. d. Univ., Bologna.)—A résumé is given of reactions occurring in non-aqueous solutions, which are similar to the hydrolyses that occur in aqueous solutions and are to be explained similarly by the conception of ionisation. The amides have an abnormally high ionisation capacity. In accord with this we find cases of amidolysis similar to those of hydrolysis.

D. H. J.

1164. *Molecular Weight Determinations in Solid Solutions.* J. Meyer. (Zeitschr. Elektrochem. 11. p. 770, Nov. 3, 1905. Paper read before the 77 Naturforscherversammlung in Meran, Sept. 24-30, 1905.)—If one enantiotropic modification of a substance contains another so as to form a solid solution, the transformation-point of the first will be displaced, and from the amount of the elevation or depression it is possible to calculate thermodynamically the molecular weight of the dissolved substance. The author finds that the transformation-temperature of white tin into grey tin is not appreciably altered by the addition of gold or silver, but when mercury is added the displacement indicates that in dilute solutions of mercury in tin the mercury exists in the monatomic condition.

T. H. P.

1165. *Studies on Formaldehyde. I. Formaldehyde in Aqueous Solution.* F. Auerbach and H. Barschall. (Arbeiten aus dem kais. Gesundheitsamte, vol. 22. No. 3. Zeitschr. Elektrochem. 11. pp. 906-909, Dec. 8, 1905. Abstract.)—A study of the condition of formaldehyde in aqueous solution from cryoscopic and vapour-pressure measurements.

A. F.

1166. *The Solution State.* W. P. Dreaper. (Chem. News, 92. pp. 229-232, Nov. 17, 1905.)—An attempt to meet the objections to the theory of electrolytic dissociation and of hydrated ions, by the introduction of an association theory, based on a large number of assumptions and hypotheses.

A. F.

1167. *Spinodal and Plait-point Curves for Binary Mixtures of Normal Substances.* J. J. van Laar. (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 582-594, Jan. 10, 1906. Proc. 8. pp. 578-590, Jan. 25, 1906.)—Normal substances are defined as those where the relations $b_{12} = (b_1 + b_2)/2$ and $a_{12} = \sqrt{a_1 a_2}$ hold [see Abstract No. 1831 (1905)]. The differential relations found by van der Waals and others are transformed into final relations $F(v, x)$. General relations between θ and π are found and compared with experiment for minimum critical temperature and maximum vapour pressure. The details of the principal types are further discussed.

H. H. F. H.

1168. *Approximate Composition of Hydrates of Electrolytes.* H. C. Jones and H. P. Bassett. (Amer. Chem. Journ. 34. pp. 290-349, Oct., 1905. Zeitschr. Phys. Chem. 55. pp. 385-434, May 18, 1906.)—The authors give an account of further work in continuation of that already published, and also a summary of conclusions arrived at up to the present. One of the main results of the authors' work is that both molecules and ions have the power to combine with water in aqueous solutions and form hydrates. [See also Abstracts Nos. 8048 (1904) and 1133, 2008 (1905).]

T. H. P.

1169. *Progressive Dissociation of Dibasic Acids. II.* R. Wegscheider. (Akad. Wiss. Wien, Sitz. Ber. 114. 2b. pp. 769-773, June, 1905. From the I. chem. Laborat. der k.k. Univ., Wien.)—A method is given by which the two dissociation constants of dibasic acids can be deduced directly from conductivity measurements; the method formerly described required a previous knowledge of one of these constants before the second could be calculated [see Abstract No. 609 (1903)].

T. M. L.

1170. *Concentration Cells with Methyl and Ethyl Alcohols.* J. H. Wilson. (Amer. Chem. Journ. 35. pp. 78-84, Jan., 1906.)—Up to the present the equations of Nernst and Planck for concentration cells have been verified only in the case of cells prepared with aqueous solutions. The author has, therefore, determined the e.m.f. of some non-aqueous concentration cells prepared with solutions of silver nitrate in methyl alcohol and in ethyl alcohol. The results observed agree with those calculated from Nernst's formula.

D. H. J.